User Guide

PCASE7

Version 7.0.4

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Pavement-Transportation Computer Assisted Structural Engineering

US Army Corps of Engineers

Development Team

US Army Corps of Engineers Research and Development Center

Dr. Carlos Gonzalez
Dr. Jeremy Stache
Ms. Lynette Barna

US Army Corps of Engineers Transportation Systems Center

Ms. Mary Adolf
Mr. George Van Steenburg
Mr. Larry Stringer

Intelligent Information Technologies Corp.

Dr. Arthur Baskin
Mr. Bill Nelson
Ms. Ruth Flores
Mr. Spencer Dickey
Dr. Robert E. Reinke
Mr. Ben Hartmann
Mr. Justin White
Mr. Jordan Smith

University of Texas at El Paso

Dr. Danniel Rodriguez

Sponsors

US Army

Mr. Michael Andres
Mr. Andrew Harrison
Mr. Peter Bly

US Air Force

Dr. Craig Rutland
Mr. Shaun Moya

US Navy

Mr. Bruce Seamans
Mr. Floreto Lomibao
Mr. Scott Herold

US Army Corps of Engineers

Ms. Georgette Hlepas, HQ USACE
Mr. Michael Alley, Alaska District
Mr. Phillip Erdman, Mobile District
Mr. Peter Wilson, Baltimore District

PCASE Acknowledgements

PCASE History

In the early 80's the Pavement Computer Assisted Structural Engineering (PCASE) Committee was formed to meet a growing need to automate the pavement design and evaluation process for the Department of Defense (DoD). The committee investigated implementing existing main-frame computer applications on Personal Computers. The US Army Corps of Engineers (USACE) Waterways Experiment Station (now the Engineering Research and Development Center (ERDC) Geotechnical and Structures Lab) played a leading role in these development efforts in the mid to late 80's.

The first PCASE modules implemented the CBR and Westergaard procedures, then followed by layered elastic modeling and analysis in the late 80's and early 90's. There were many individuals involved in the research and development efforts that expanded the existing criteria and implemented the evolving criteria in PCASE. Key contributors include: Mr. Don Alexander, Dr. Walter Barker, Dr. Al Bush, Dr. Frans Van Cauwelaert, Dr. Yu T. Chou, Dr. Ray Rollings, and Dr. Jacob Uzan.

In the mid-1990's, PCASE consisted of individual Disk Operating System (DOS) based programs. At this time, Ms. Mary Adolf, USACE Transportation Systems Center, was the PCASE Program Manager. She teamed with Mr. Don Alexander, Dr. Walter Barker, Dr. Carlos Gonzalez, Mr. Robert Walker, Mr. John Lott, and Ms. Lora Johnson to convert the DOS PCASE programs to an integrated Windows application. As part of the Windows update, the team engaged with the PAVER™ Program Manager, Dr. Mo Shahin, ERDC Civil Engineer Research Lab, to integrate PCASE and PAVER™ inventory capabilities. With the help of Dr. Shahin and the PAVER™ development team they were able to leverage existing PAVER™ inventory tools and complete the Windows update in 2001.

In subsequent years, development team members departed, and new team members were added including Ms. Lynette Barna, Dr. Alessandra Bianchini, Dr. Jeremy Stache, and Dr. Danniel Rodriguez. Mr. George VanSteenburg took over the PCASE Program Manager role in 2016, when Ms. Adolf retired. The team continued to implement new criteria and maintain and update the PCASE application. In 2015, Intelligent Information Technologies (IIT) joined the development team to support the effort to modernize PCASE. The objective of the modernization effort was to update the PCASE engineering code, enhance interoperability with PAVER, and introduce new user interfaces using the Microsoft .Net Framework and Object-Oriented programming concepts to meet current programming and cyber security standards. This effort culminated in the release of PCASE 7.0.1 in October 2021.

Proponents

USACE Districts provide the core funding for PCASE since the early 00's. The Air Force has been a sustaining PCASE supporter since its inception with key efforts funded by the Army and the Navy over the life of the program. Since the inception of the USACE Transportation Systems Center (TSC), its directors have been staunch PCASE advocates providing ongoing support.

- HQ USACE
    - Mr. David Bohl
    - Mr. Paul Dicker
    - Mr. Greg Hughes
    - Ms. Jennifer Kline
    - Ms. Mackenzie Searle
- USACE Transportation Systems Center
    - Mr. Terry Sherman
    - Mr. David Ray
    - Mr. Steve Carter
- US Air Force
    - Mr. Jim Greene
    - Dr. Craig Rutland
- US Navy
    - Mr. Greg Cline
    - Mr. Vince Donnally
    - Mr. Joe Woliver

PCASE Tri-Service Working Group (TSWG)

The PCASE Tri-Service Working Group has served as the governance body for the application since the 90s. The name has changed over time, but its function has been to guide PCASE development by providing feedback, prioritizing requirements, and advocating for funding support. The PCASE TSWG is made up of the Service proponents, the development team, and representatives from USACE Districts and appointees from each Service who are actively engaged in pavement design and evaluation. Their collective efforts of the past TSWG members listed below have ensured PCASE remains current and relevant.

- USACE Districts
    - Mr. Larry Dorsey
    - Mr. Stan Gembicki
    - Mr. Randy Goff
    - Mr. Oz Keifer
    - Mr. Tom Mack
    - Mr. Ken McInally
    - Mr. John Rajek
    - Mr. Tom Rossbach
    - Mr. Ron Shafer
    - Mr. Larry Stringer
    - Mr. Dave Tucker
- USACE TSC
    - Mr. Kordon Kiel
    - Mr. Danny Klima
    - Mr. Walt Perron
- ERDC CRREL
    - Dr. Richard Berg
    - Dr. Edel Cortez
    - Mr. Vince Janoo
    - Ms. Maureen Kestler
- ERDC-GSL
    - Mr. John Lott
    - Ms. Lora Johnson
    - Dr. Danniel Rodriguez
- US Air Force
    - Mr. Harold Muniz Ruiz
    - Mr. Richard Smith
    - Mr. George VanSteenburg
- US Navy
    - Mr. Vince Donnally
    - Mr. Greg Cline

Ms. Adolf, Dr. Gonzalez, and I want to express our heartfelt thanks to the current development team members and the many people who have helped guide us and contributed to the development and success of PCASE over the years. Thank you!

George VanSteenburg
PCASE Program Manager
US Army Corps of Engineers
Transportation Systems Center (TSC)
George.w.vansteenburg@usace.army.mil

Disclaimer

Table of Contents

1 Introduction to PCASE 7

1.1 Scope and Purpose

1.1.1 Purpose

PCASE 7 is software for the design and evaluation of airfields and roadways according to US Department of Defense criteria.

Design determines the thickness required for pavements in non-frost and frost areas.

Evaluation determines the load-carrying capacity of pavements (used or to be used). An evaluation is conducted to assess the allowable traffic that a pavement can sustain for given loading conditions or the allowable load for a given amount of traffic without producing distress.

US Department of Defense criteria used for the development of PCASE	
Unified Facility Criteria	**Description**
UFC 3-201-01	Civil Engineering
UFC 3-250-01	Pavement Design for Roads, Streets, Walks, and Open Storage Areas
UFC 3-250-09	Aggregate Surfaced Roads and Airfields Areas
UFC 3-260-01	Airfield and Heliport Planning and Design
UFC 3-260-02	Pavement Design for Airfields
UFC 3-260-03	Airfield Pavement Evaluation

1.1.2 Module Features

PCASE7 includes the capability to perform pavement designs and evaluations, analyze Falling Weight Deflectometer (FWD) and Dynamic Cone Penetrometer (DCP) data, and track physical property data. The PCASE tools include:

Design Module - capable of designing roadway and airfield flexible, rigid, mat (airfield only) and aggregate pavement using the following models:

- Layered Elastic for flexible and rigid pavements
- California Bearing Ratio (CBR) Stress-Based (CBR-Beta) for flexible pavements
- Westergaard Plate Solution (k) for rigid pavements
- CBR-Alpha for aggregate and mat surfaced pavements

The Design Module is also capable of calculating the required subsurface drainage layer thickness, overlays, airfield shoulders, and account for seasonal variations.

Evaluation Checklist - displays sections in an Evaluation and the APE and LEEP status. Sections can be added, edited and deleted.

LEEP evaluation - capable of analyzing pavements using the layered elastic method producing resultant allowable loads, passes, Pavement Classification Numbers (PCN), and overlay requirements.

APE evaluation - capable of analyzing pavements using the empirical method producing resultant allowable loads, passes, Pavement Classification Numbers (PCN), and overlay requirements.

FWD data - capable of importing and viewing falling weight deflectometer (FWD) data, defining section boundaries, and assigning data for backcalculation.

DCP data - capable of analyzing field Dynamic Cone Penetrometer (DCP) data and providing resultant pavement layer strengths.

PPD - provides a spreadsheet of Physical Property Data (PPD), cursory pavement condition survey, and construction history data. The PPD tool is currently under development and will be added to PCASE 7 in a future version.

1.1.3 Benefits

PCASE provides the ability to perform pavement thickness designs quickly and thereby providing the ability to make decisions faster and with precision and consistency. PCASE is also used for determining pavement life. The analysis information obtained from the software (allowable passes, loads, pavement classification numbers, etc.) is critical to engineers, pilots, and airfield administrators.

1.2 Downloading and Installing the Software

1.2.1 Recommended Hardware

Memory: 2 GB RAM for 32-bit desktop
4 GB RAM for 64-bit desktop for small to medium databases
8 GB RAM for 64-bit desktop for large databases (10,000+ sections)

The PCASE 7 user interface is designed for use on modern desktop and laptop screens. A minimum screen resolution of 1920 x 1080 pixels is recommended. At that resolution, a screen scale of no more than 150% is recommended

1.2.2 Upgrading to PCASE 7

PCASE 7.0 and the PAVER™ pavement management application can share the same database which is particularly useful for pavement evaluation since both pavement condition surveys, and structural evaluations use the same inventory data. PCASE 7.0 supports the import of PAVER™ *.e60, *.e65, and *.e70 files. Users should export their file(s) to one of these formats, and then, import the file(s) into PCASE 7 using the File Menu: New/Import >> New/Import pavement database.

To import a PAVER™ 5.x database users must import the *e.5x file to PAVER™ 6 and then export an *.e60 or *.e65 file. PCASE 7.0 **does not** support the import of PAVER™ *.e5x files.

1.2.3 32-bit and 64-bit Versions of PAVER™

PCASE 7.0 can be installed on 32-bit or 64-bit Windows computers. On a 64-bit computer, desktop icons for both versions will be put on the desktop during the install.

With the 32-bit version of PCASE 7.0, the user can use JET (Microsoft Access-based), SQL, or SQL Local DB databases. Local DB will be installed with PCASE, but if the user chooses to use SQL databases, then the computer must be able to access an instance of SQL (Express, Server, etc.).

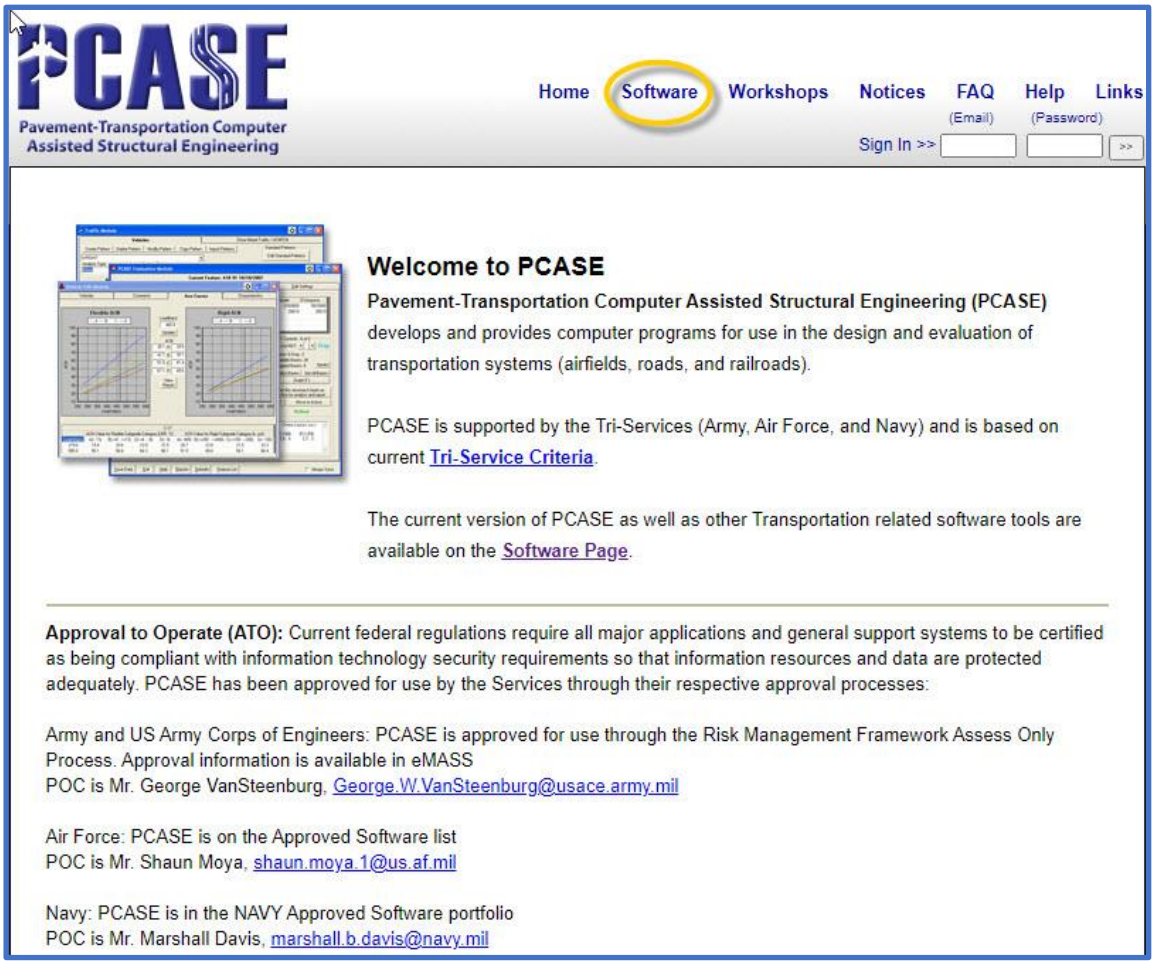
The 64-bit version uses only use SQL databases so an instance of SQL must be available for use by the PAVER™ inventories.

1.2.4 Using SQL

SQL Server/Express 2012 or later is required. Inventories in SQL are stored in SQL's data directory, not in the user data folder. Prior to upgrading SQL, users should backup databases to E70 in order to prevent data loss during the upgrade process.

1.2.5 Link to the software

To download the PCASE software, go to the PCASE website at www.pcase.com or https://transportation.erdc.dren.mil/pcase/. Click on “Software” as shown below.



1.2.6 Installing the software

Once you have downloaded the file, browse to the file PCASE 7.0.x setup and double-click on it to activate the Setup Wizard; click Next to continue. After reading the License Agreement, select Accept. On the Type of Setup screen select Typical or Custom (to select which features are installed). Next browse to the installation folder; the default is C:\Program Files (x86)\EMS\. On the Begin Installation screen select Install. When the installation is complete, click Finish. The installation creates an icon on your desktop called PCASE 7.0.x. Double-click this icon to start using PCASE 7. If you do not have write permissions to your computer you will need to contact your Information Technology department to install the software.

1.3 Updates to PCASE7

1.3.1 Improvements to PCASE

1. A single database can contain multiple evaluations and design projects.
2. In addition to Microsoft Access, there are two new database management system options; Local DB and SQL Server.
3. PCASE 7 is multi-user capable.
4. File format has changed from PCASE Zip files (.EMSZ) to .e70.
5. User-edited vehicles travel with the database.
6. Separate APE and LEEP forms that can be open simultaneously for easy comparisons.
7. Unified Design form with less steps.
8. Separate traffic forms for designs and evaluations. Traffic is defined within each module as part of the workflow.
9. Less repetition of data entry; default values now auto-populate and range checking messages have been implemented to display the correct value ranges for specific criteria.
10. Forms have customization options; panels can be resized and collapsed, layer model grid layouts can be revised and saved, APE and LEEP form layouts can be saved.
11. Multiple options for combining different types of data.
12. Added PCASE Data Assignment tool to allow moving inventory data within a database.
13. Added ACN/ACR Charts.
14. Preference options for criteria and default moduli settings.
15. Addition of Controlling Traffic Mode options in APE and LEEP.
16. Added Mission Critical Aircraft for ACN functionality.
17. Updated precipitation and weather databases.
18. Changed terminology for Slip to Bond and enabled modifying the Bond values for each layer.
19. Added ability to create Ad Hoc sections in APE and LEEP.
20. Made optimizations to DCP.

1.3.2 Calculation differences

- **Design**
  - **Airfield Design**: In PCASE 7, we have increased the minimum design thickness for stabilized base and subbase layers for flexible airfields to 6” (from 4” in 2.09). As a result, flexible airfield designs with a stabilized base or subbase may have larger computed thicknesses than in PCASE 2.09.
  - **Roadway Design**: PCASE 2.09 and PCASE 7 use different methods for calculating ESALS. ESALs are used in determining minimum pavement thickness for roadways, and the minimum thickness can affect the relative thickness calculated for the layers in the design. Overall, we expect the total pavement thickness to be the same in the two systems (within a 1” tolerance) but the

minimum thickness differences can result in different layer thicknesses. For example, PCASE 2.09 may compute a minimum thickness of 2” for the asphalt layer in a flexible roadway for which it calculates that the total thickness of asphalt plus base should be 10”. In this case, PCASE 2.09 will recommend 2” for the asphalt layer and 8” for the base. But PCASE 7 may compute (based on a different ESAL value) a 3” minimum for the asphalt and recommend a design of 3” of asphalt over a 7” base.

- **Frost Design**: In PCASE 2.09, the FASSI value (derived from the layer frost code) is used in computing the RSS thickness for the subgrade. In PCASE 7, this has been changed so that if the subgrade CBR is less than the FASSI value, the subgrade CBR value is used instead.

- **APE/LEEP Common**
  - **PCN String Tire Code**: In PCASE 7, different logic is used to calculate the tire code in the PCN string, causing it to differ from the 2.09 value in some cases. In PCASE 2.09, the tire pressure code is always “W” (No Limit). In PCASE 7, the tire pressure code can be W, X (182-254), Y (74-181), or Z (0-73) depending on the minimum thickness requirements and condition.
    Rigid Pavement: Tire pressure has little effect on pavements with Portland Cement Concrete (PCC) surfaces. Rigid pavements are inherently strong enough to resist high tire pressures and can usually be rated as Tire Pressure Code W. However, when the rigid layer is very thin (less than 4 inches) or is thoroughly shattered (pieces less than 2 feet wide), the pavement should not be rated above 100 psi (Tire Pressure Code Y). In cases of thin bonded overlays (such as surface scaling repairs) when one suspects poor bonding between the repair material and the original concrete surface, the tire pressure code should also be reduced (Tire Pressure Code X).

    Flexible Pavement: Tire pressures may be restricted on flexible pavement depending on the quality of the asphalt mixture, climatic conditions, or thickness and condition of the surface. Tire pressure effects on an asphalt layer relate to the stability of the mix in resisting shearing or densification. A properly prepared and placed mixture that conforms to DoD specifications can withstand tire pressures in excess of 254 psi (Tire Pressure Code W). Pavements that are thinner than the minimum required thickness should be rated with Tire Pressure Code X. Pavements of poorer quality asphalt (aged or severely cracked pavements) should not be rated above 100 psi (Tire Pressure Code Y).
  - **Joint Deflection Ratio Calculation**: For rigid pavements, the calculation method used for determining joint deflection ratio from load transfer percent is slightly different in PCASE 2.09 and PCASE 7. For load transfer percentages less than 25%, PCASE 2.09 and PCASE 7 produce slightly different joint deflection ratios (e.g., at 20% load transfer, PCASE 2.09 gives a joint deflection ratio of 0.65 where PCASE 7 computes 0.67). This can result in different allowable load/pass values in these cases. When equal joint deflection ratios are used, the results match.
  - **AC Overlay Thickness with Low CBR Base**: On flexible pavements when the base or subbase CBR is less than 80 for airfields or less than 40 for roads, PCASE 2.09 does not count these layers as contributing to the minimum required thickness. It then adds to the calculated overlay thickness to compensate for the

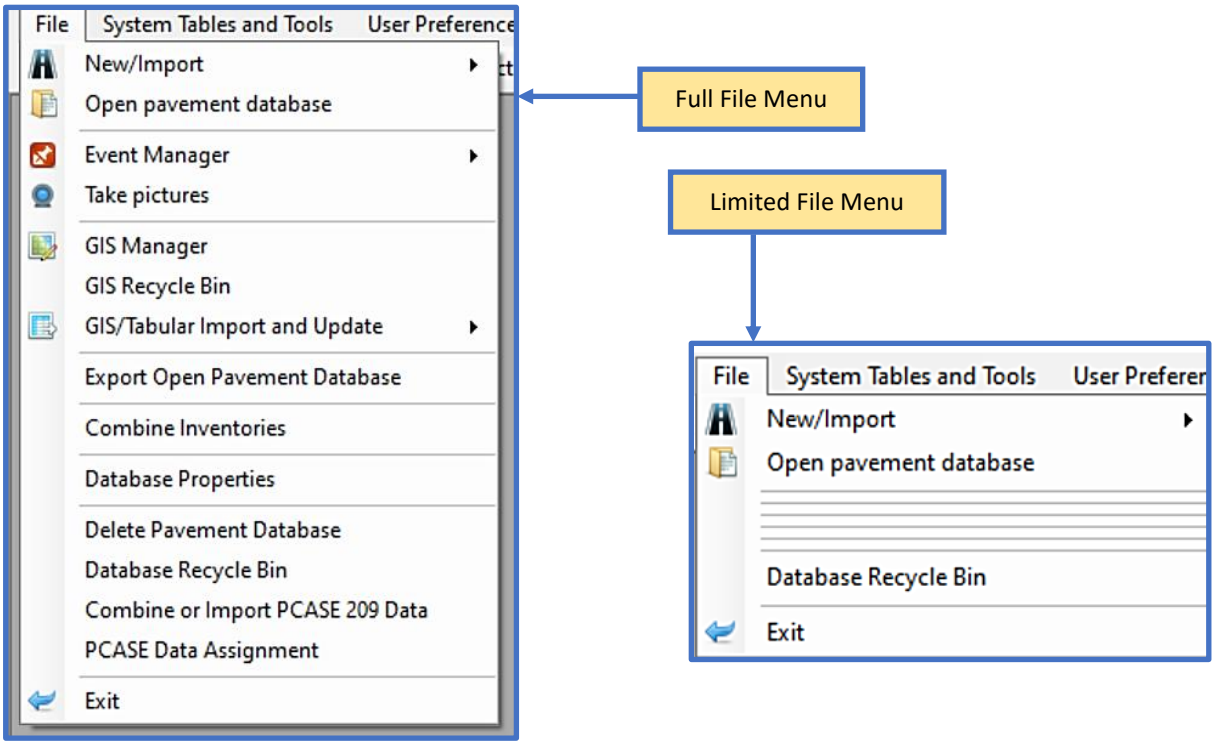
"missing" base/subbase. This causes PCASE 2.09 to have a larger overlay thickness than is actually needed to support the evaluation vehicle. In PCASE 7, the overlay thickness is only what is needed to support the evaluation vehicle.

- **Different PCN Values for Large Relative Loads**: PCASE 2.09 and PCASE 7 use different techniques for computing ACN and PCN. In PCASE 2.09, these are computed using fixed slopes and intercepts stored in the vehicles database. In PCASE 7, these are calculated when they are needed. In most situations, these techniques produce the same results (typically plus or minus 1 point). But in cases where the AGL is much larger than the vehicle under consideration, these two methods can differ by more. For very light vehicles (such as a drone) on strong pavements, both methods will produce very large PCN numbers (in the hundreds), but the two methods may report PCN values that differ by tens of points.
- **Overlay Calculation**: In PCASE 2.09, the reported overlay thickness is the maximum of the calculated overlay thickness and the minimum overlay thickness. In PCASE 7, the reported overlay thickness is just the calculated overlay thickness.

- **APE**
  - **Result AGL and Passes for Unsurfaced**: For Unsurfaced/Mat pavements, PCASE 2.09 reports the resulting AGL and Passes based on the subgrade. In PCASE 7, we report the result as the lowest value of the subgrade or any intermediate layers.
  - **Invalid Minimum Thickness for Roadways**: In some cases, PCASE 2.09 is using an invalid 5" minimum thickness for roadways. Per the UFC, the largest minimum thickness for roadways is 4".
  - **PCC Overlay (with frost analysis) when AGL Supports Vehicle**: On rigid pavements with frost, PCASE 2.09 sometimes adds PCC overlay thickness even when the computed AGL will supports the evaluation vehicle. PCASE 7 does not do this, which is the correct behavior.
  - **Incorrect AGL when Value is Outside Vehicle Bounds**: In cases where the computed AGL is less than the minimum vehicle weight or greater than the maximum vehicle weight, PCASE 2.09 has a bug in its AGL calculation. PCASE 7 does not have this bug.
  - **Incorrect Subbase Equivalency Factor for 100 CBR Base over Stabilized Base**: In cases of a flexible pavement with a 100 CBR base over a stabilized base, PCASE 2.09 appears to be calculating the equivalent subbase thickness incorrectly – it gives a smaller equivalent subbase thickness for the base at CBR = 100 than at CBR = 80. PCASE 7 does not have this bug.
- **LEEP**
  - **Computation of Effective K**: For certain rigid layer models, the method PCASE 2.09 is using for determining effective K from modulus appears to be incorrect.
  - **Vehicle Contact Area**: PCASE 2.09 had incorrectly calculated tire contact areas for several vehicles, most notably the C-17A. This can cause differences from PCASE 2.09 in the resulting allowable passes when using WESPAVE/WESDEF mode in LEEP.

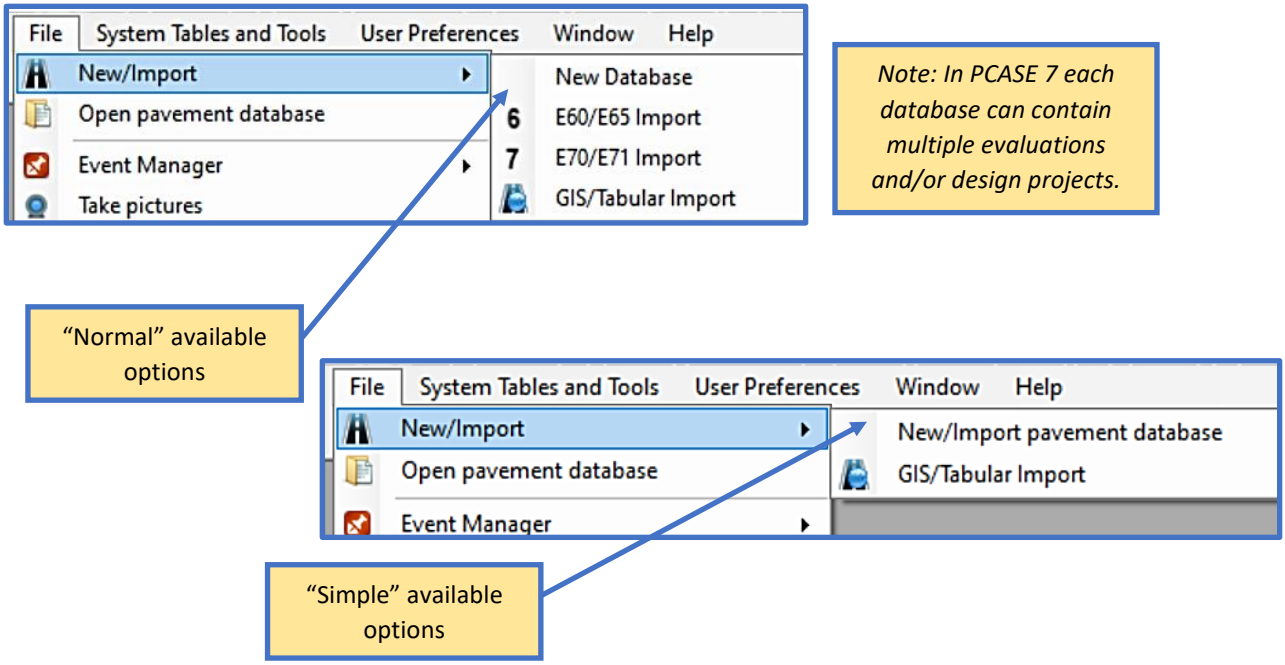
2 File Menu

The File menu consists of options that pertain to handling user data or databases. A database must be open for all of the below options to be displayed. If PCASE 7 detects that a database has not been opened, only the limited options will be visible.



2.1 New/Import

The first time you use PCASE 7, you will need to create or open a database before you can begin. Use the New/Import options to create or import a database. The options that are displayed within the New/Import list are dependent upon the Normal or Simple preference option that can be selected in User Preferences > Defaults > Menus. The Normal vs. Simple option also affects the format of the Create New Pavement Database form. We recommend that PCASE 7 users default to Simple. Changes made in the Menus tab require a program restart to take effect.



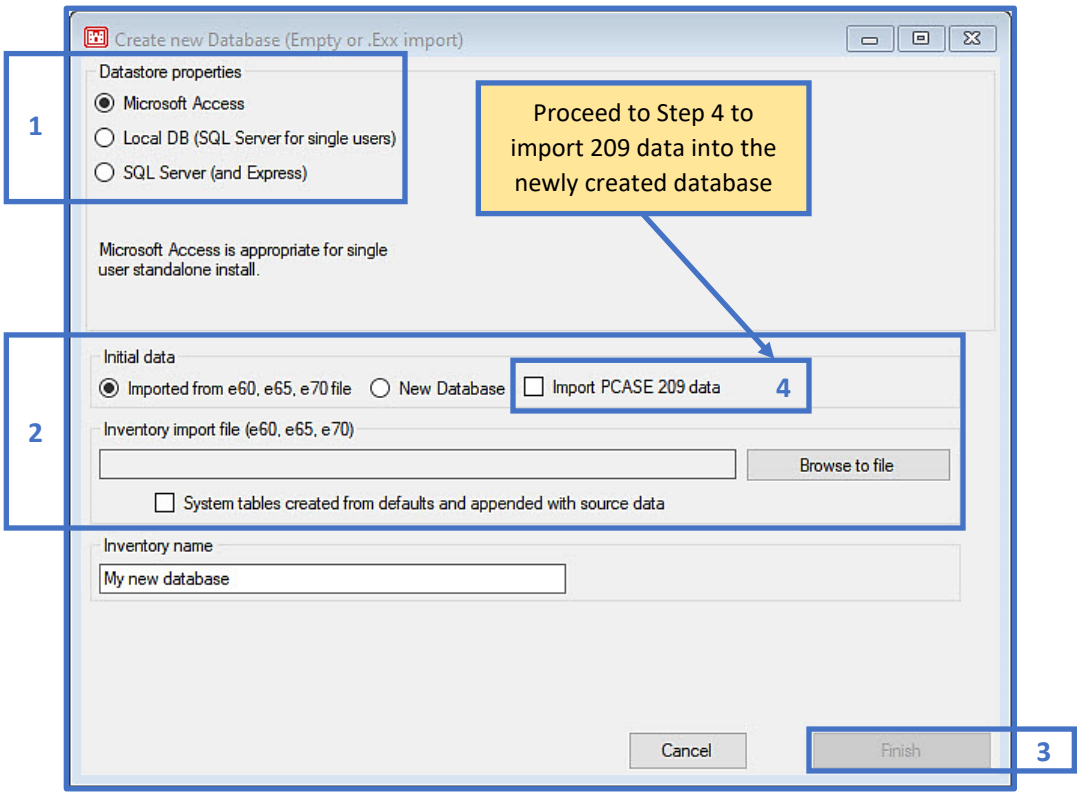
2.1.1 New/Import pavement database

Create a new PCASE 7 database or import an existing E60, E65, or E70 database by selecting the New/Import > New/Import pavement database option. Once the Create New Database form opens:

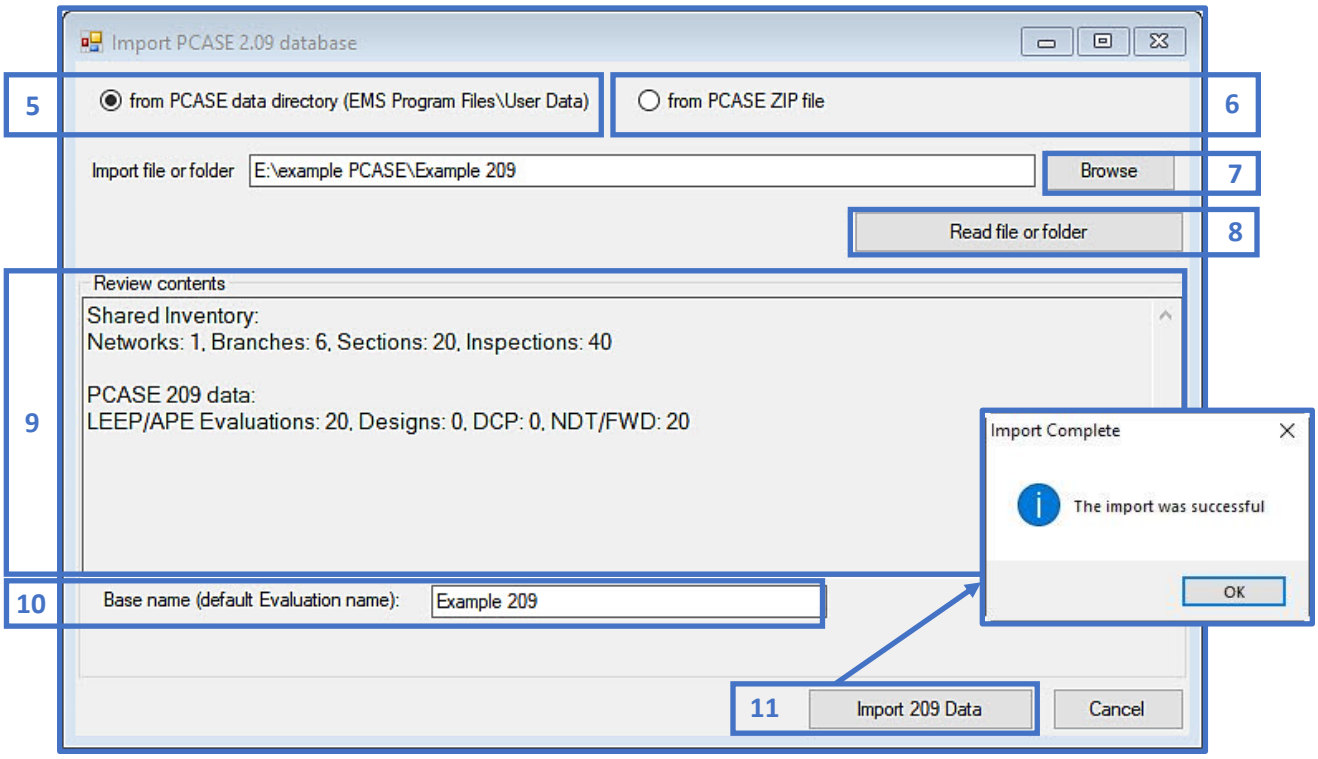
1. Choose a Datastore properties option: Microsoft Access is the recommended default option suitable for most single user, standalone installs. Local DB and SQL Server are both options for SQL Server users; these options support larger databases and SQL Server supports multiple users.
2. If you opted for Microsoft Access, choose from one of the three radio button options within the Initial Data group:
    - Imported from e60, e65, e70 file enables import of a database with an .exx file extension; use this option if you have existing PAVER™ data. Select the Browse to File button to locate the file through your File Explorer. Once the file has been selected, the file path will populate in the form's Inventory import file field. Check the System tables created from defaults and appended with source data checkbox, if applicable.
      Note: The System tables created from defaults and appended with source data option should only be selected if you have made modifications to standard Systems tables in the source database which is not typically allowed by the unified facility criteria.

- Use the Inventory Name that populates automatically (if an .exx file was provided) or give the database a new name.
- The New Database option will create a blank/empty database. Once the radio button has been selected, name the new database using the Inventory name field, then select Finish.
- The Import PCASE 209 data option can be used to import a PCASE 209 database into an existing or new PCASE 7 database. The Import PCASE 209 database form will open once the database has been created.

3. The Finish button will enable once the required fields have been satisfied; select Finish to create the database.
4. If you selected Import PCASE 209 data, another form will open once the database has been created. Continue with the steps below to complete the import process.



5. Choose the first radio button option from PCASE data directory (EMS Program Files\User Data) if you have PCASE 2.09 installed on your computer with existing databases.
6. Choose the second radio button from PCASE Zip file, if you have a .zip export from PCASE 2.09.
7. Browse to the appropriate directory or .zip file and select it.
8. Select Read file or folder for the program to check the data selected, and to make sure it is compatible.
9. The results of Read file or folder will appear in the Review contents section.
10. PCASE 7 allows you to have data from multiple locations and times, which appear within a single database called "Evaluations". The data you are importing can be found under this evaluation name; a default name is provided here and can be changed.
11. Once all of the required fields have been satisfied, the Import 209 Data button will enable. Select the Import 209 Data button to execute the import process. Once the 2.09 database has been successfully imported, a pop-up window will confirm this action.

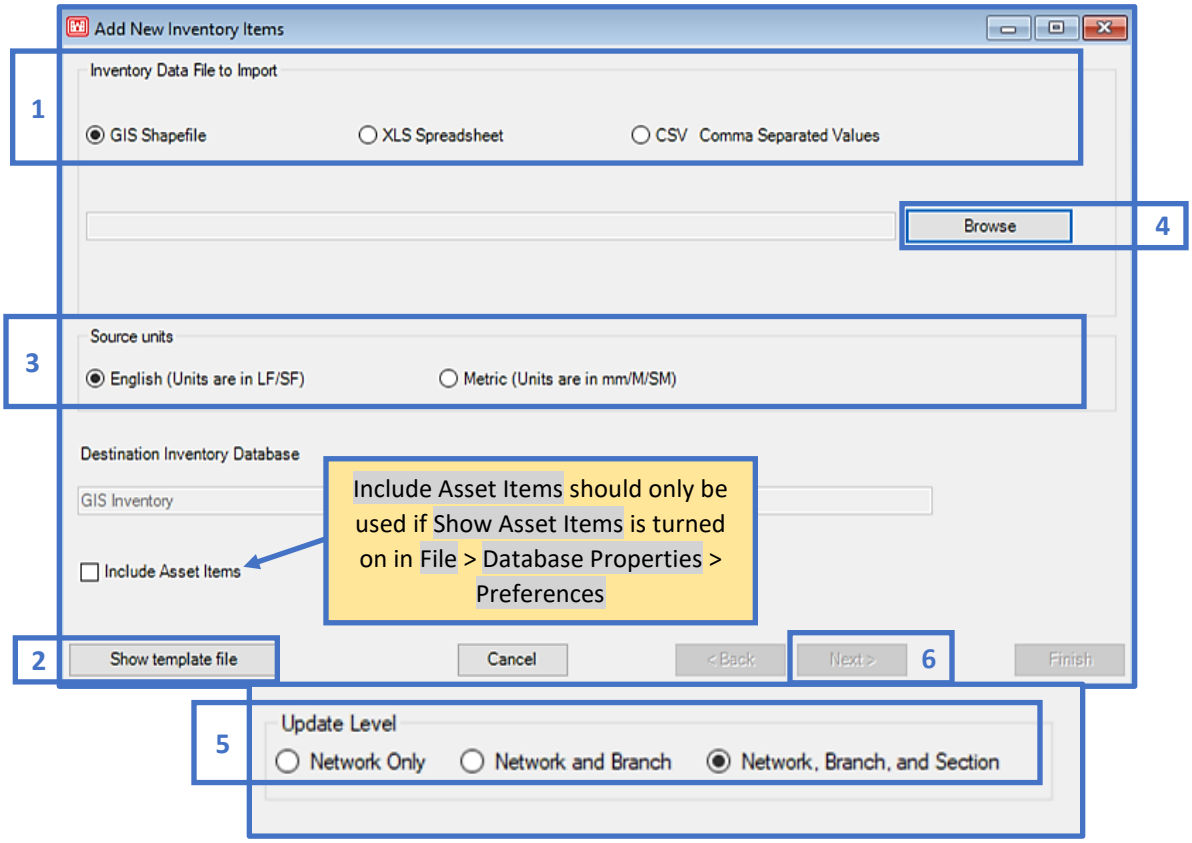


2.1.2 GIS/Tabular Import

This option has not been fully implemented in PCASE 7, but it will be included in a future version. The logic must first be modified to handle imported PCASE data properly; as it's currently designed to only work with PAVER™ formatted data.

The GIS/Tabular Import option opens the Create New Database form so that you can create a new database to bring GIS/Tabular Import data into. After the database has been created, another form will open allowing you to continue the GIS or Tabular import process.

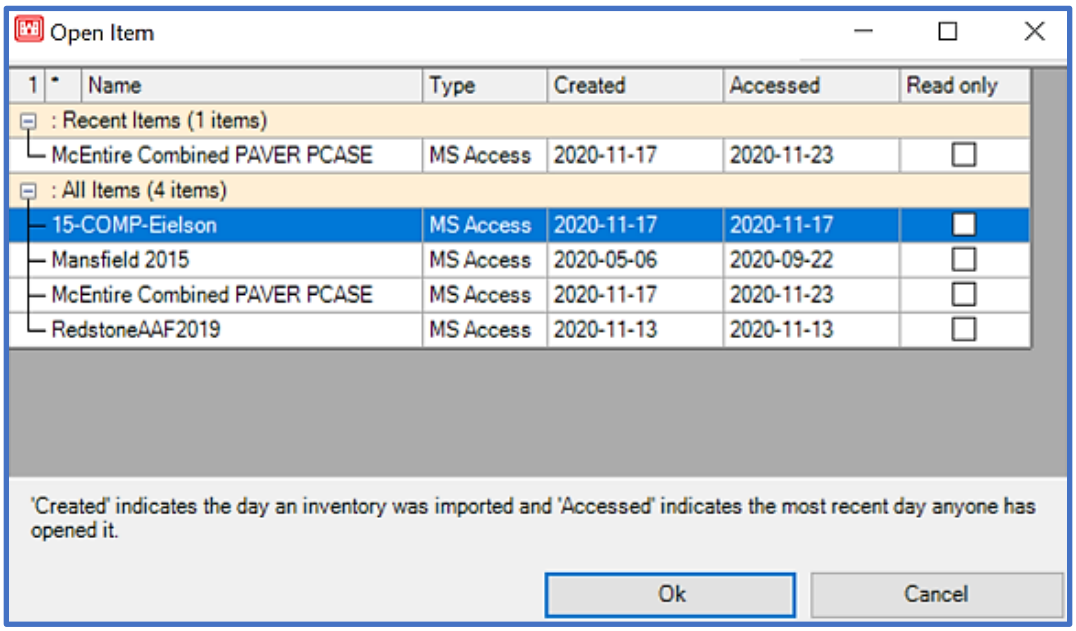
1. Select the file type you wish to import from the Inventory Data File to Import section.
2. The Show template file button invokes an Excel template file, which displays the format of the column fields.
3. Modify the Source units selection, if applicable.
4. Browse to the location of the file.
5. If you have Include Asset Items checked, the Update Level options will populate below the Include Asset Items check box once a file path has been established.
6. The Next button will enable once all the necessary fields have been satisfied. Additional forms will open with options to update inventory items, user-defined fields, and to validate and complete the import process.



2.2 Open pavement database

The Open Item window contains two trees; the top tree displays most recently opened databases and the tree below the Recent Items section lists all databases that you've imported into PCASE 7. Select a database from one of these lists, then select the Ok button, or double-click the item to open it.

Note: A database must be open in order to use all PCASE 7 functionalities. If a database has not been opened, most options will be disabled.



2.3 Event Manager

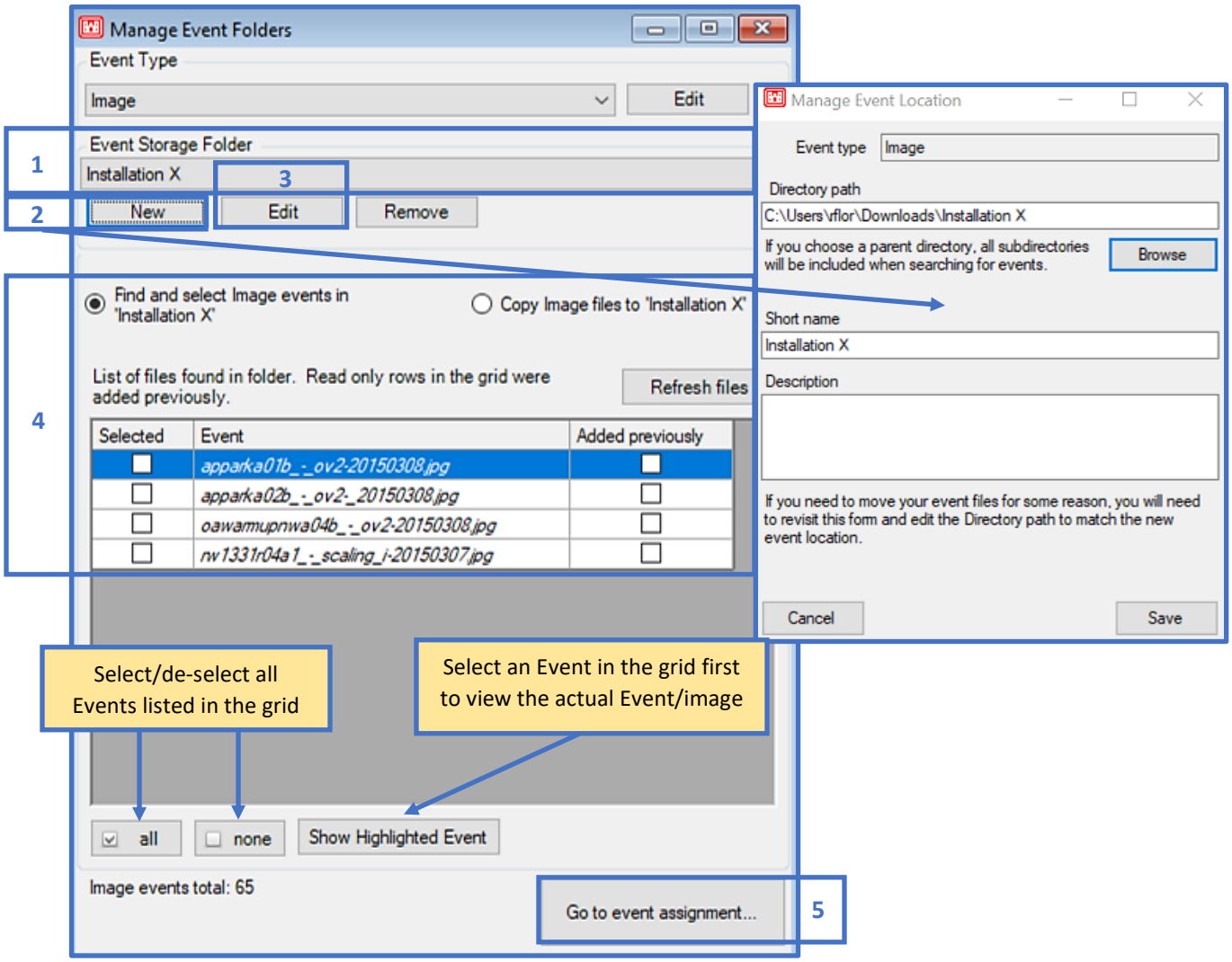
The Event Manager has two options: Manage Event Folders and Assign Events. These options allow you to decide what to do with Events/images that are associated with the database you are using. The term "Event' can be thought of as synonymous with "file," most often an image file. PCASE 7 can systematically recognize Event folders/Events, however, this does not mean the files are available on your computer. Before using the Event management tools, ensure you have the Event Storage Folder you would like to use in PCASE 7 available on your computer.

2.3.1 Manage Event Folders

Upon selecting the Manage Events option, a form will open displaying a grid containing Events/images PCASE 7 recognizes.

1. If there are multiple Event folders associated with PCASE 7, you can select which folder you would like to use from within the Event Storage Folder drop-list.
2. The New button invokes a form in which you can Browse to an Event folder on your computer; a link between the selected Event folder (and the Events/images contained within that folder) will be made with PCASE 7.
3. If you have changed an Event folder's directory path location and would like to reestablish the link between the Event folder and PCASE 7, select the Edit button.

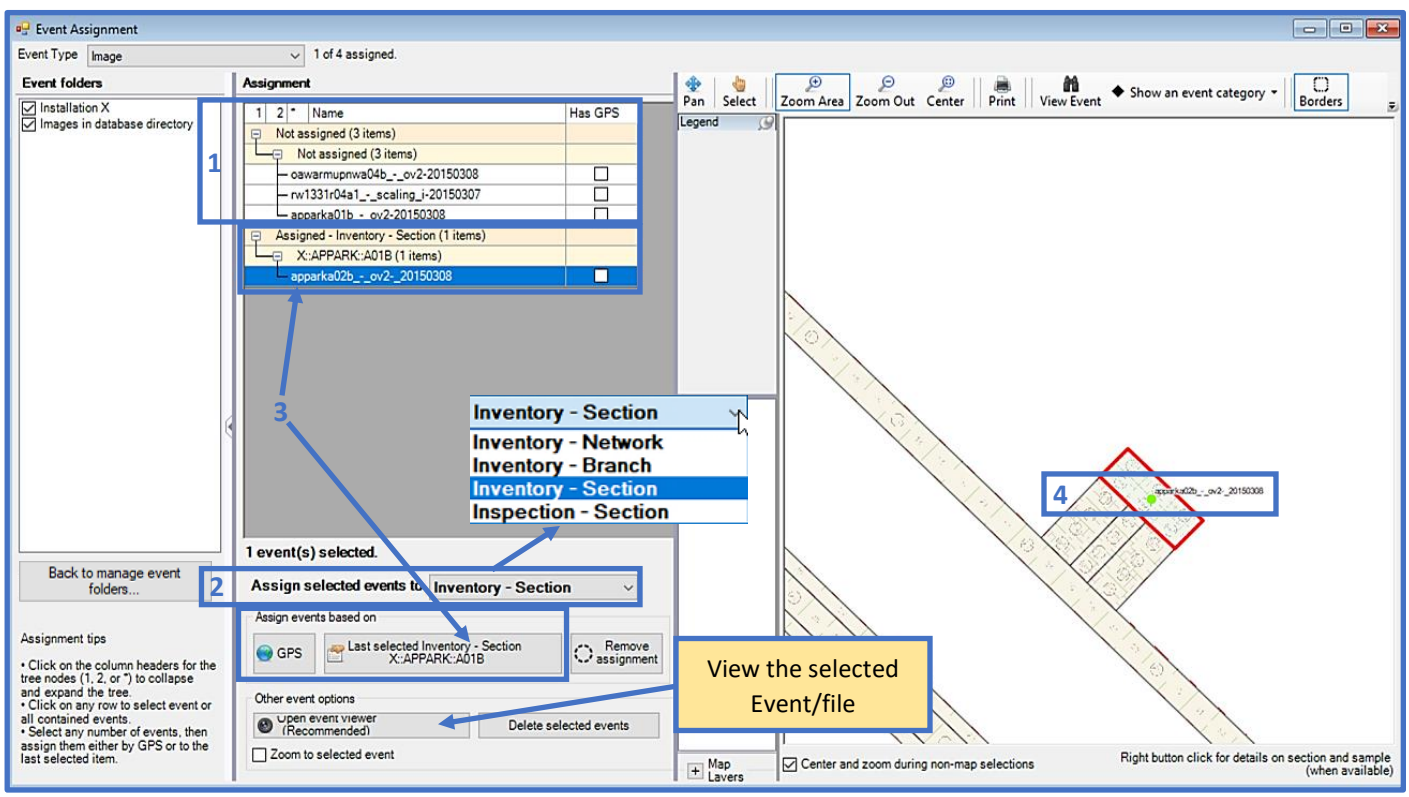
4. Below the Event folder options are two radio buttons allowing you to choose what you would like to do with the Events that are listed in the grid. The left radio button keeps you in selection mode to choose Events for assignment. The right radio button allows you to Browse to and directly upload Events from your computer for assignment.
5. Once you've completed Event selection, proceed to Event assignment.



2.3.2 Assign Events

The Event Assignment form can be accessed directly from the Event Manager options within the File Menu or by clicking on the Go to event assignment… button within the Manage Events form. Events can be assigned at Section, Branch, or Network level.

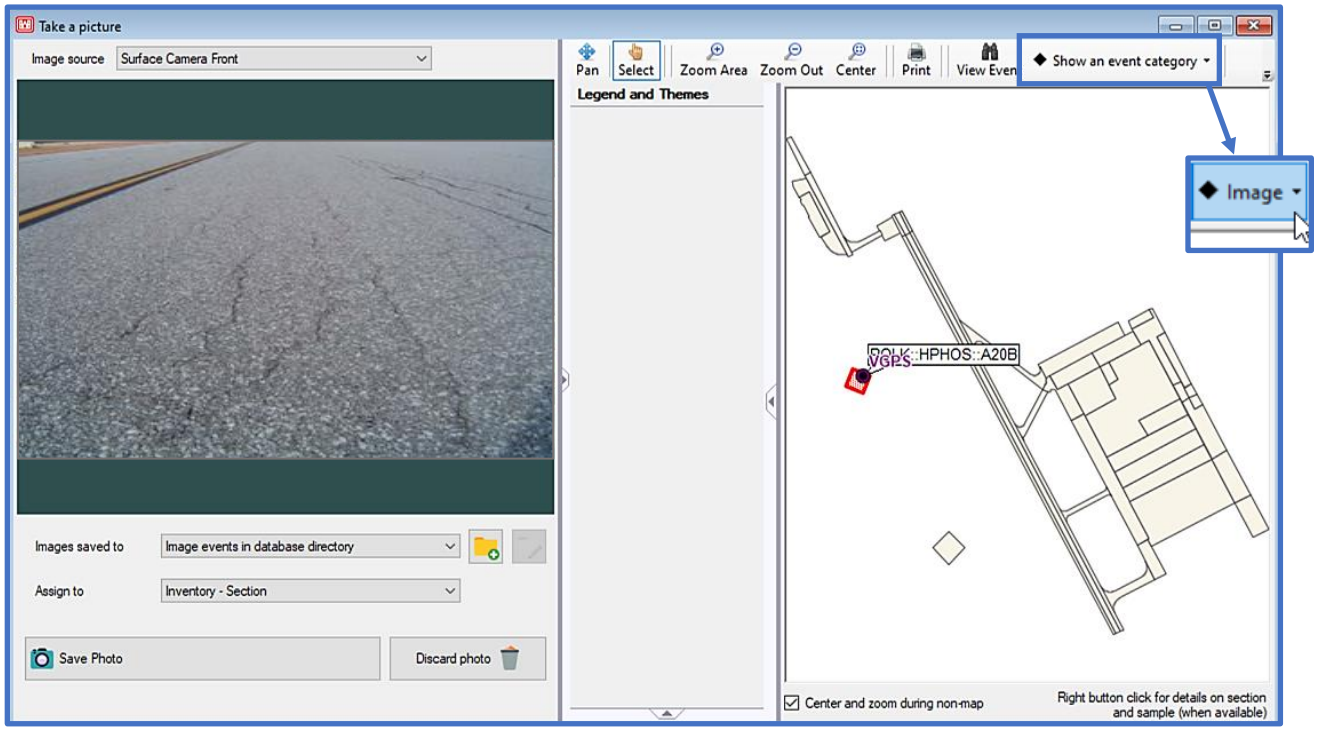
1. Once the Event Assignment form opens, the selections made in the Manage Events form will be displayed in the Assignment tree as Not assigned. Click on the Event(s) listed in the tree to select them for assignment, multi-select works with all selection trees in PCASE 7.
2. Choose which level you would like to assign the selected Events to, from the Assign selected events to drop-list.
3. Select how you would like to assign the selected Events; by GPS or to the Last selected Section to finalize Event assignment. Once you've made your selection in this section, the assigned Event(s) will appear at the bottom of the tree as Assigned. *Note: To use the GPS assignment feature, you will first want to turn on GPS in Preferences > GPS Device. Reference the PAVER™ User Guide for more information on GPS functionality.*
4. The assigned Event will now be visible in the map with a green dot to the left of the Event name label. In PAVER™ maps, green coloring indicates that the item is assigned and red means unassigned.



2.4 Take Pictures

The Take a picture form provides tools to capture, save, and assign images to defined inventory Network, Branches, and Sections.

To use the picture-taking function, PCASE 7 will need permission to access your camera. Ensure the "Allow desktop apps to access your camera" option is turned on in your computer camera settings before you open the form. An image from your camera should be displayed in the image viewer. The Images saved to drop-list contains available image storage options. Image events in database directory is the default location where images will be saved, click on the button if you would like to choose a different location, then follow the prompts to establish a link with the folder you would like to save images to. Choose the inventory level in which images will be assigned by using the Assign to drop-list, then select the location within the GIS map you wish to assign images to. Once you're satisfied with the above selections, you can proceed with snapping images using the Take photo button. After an image has been captured; options to save or delete the photo will appear. If you opt to Save Photo the image will be assigned to the selected location and the camera will reset. Delete photo resets your camera so that you may take another photo.

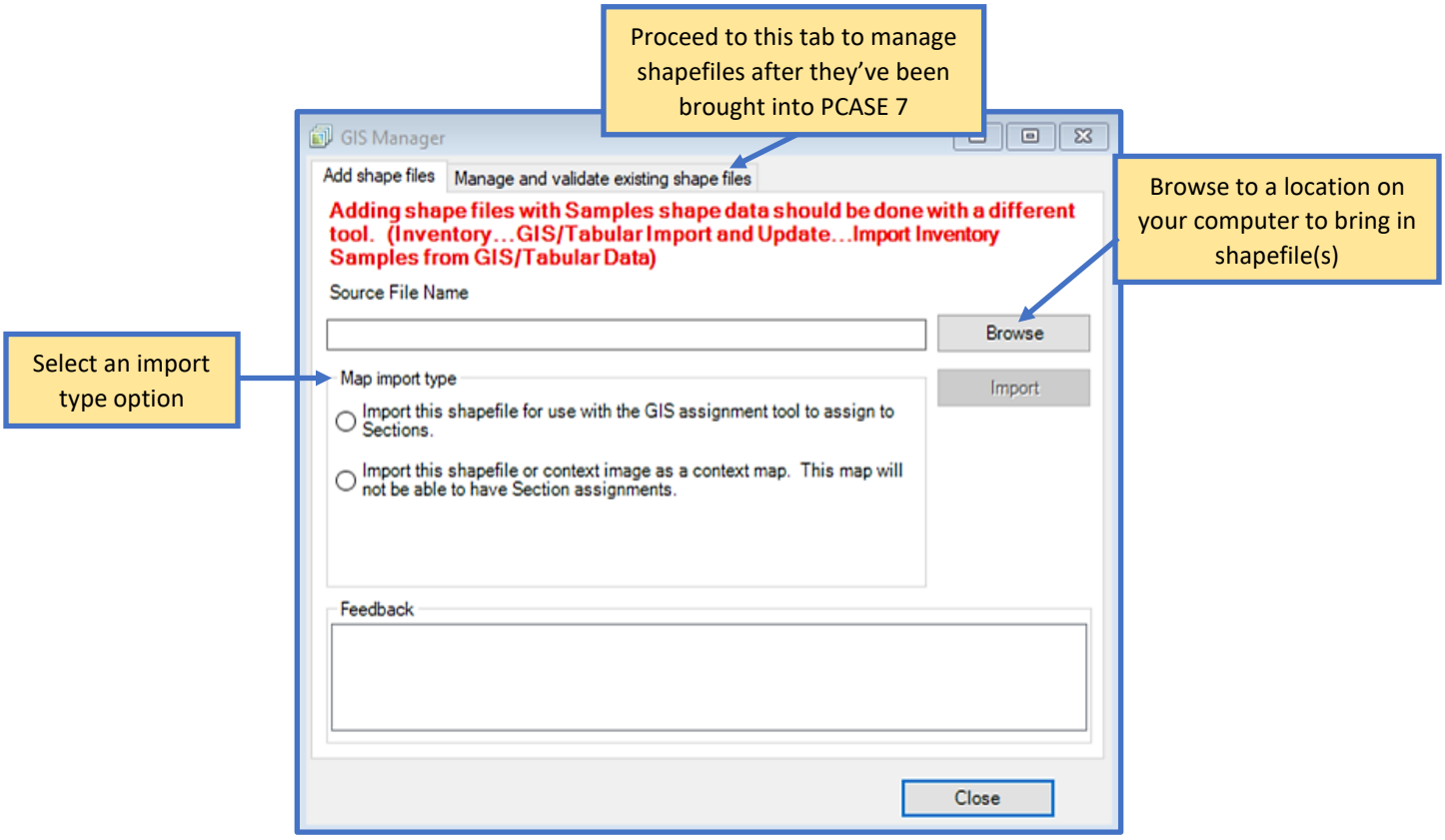


You can view newly assigned images using the Image Viewer. Click on Show an event category, then select Image from the menu. The Image Viewer will open when you select a point on the map that contains images. Alternatively, you can view images assigned to inventory via the inventory form by clicking on 1 located on the bottom-left of the Section form.

2.5 GIS Manager

The GIS Manager allows you to attach a shapefile map to a database, shapefiles that are already attached to a database can be deleted or validated using this tool as well. The GIS Manager does not add the properties of shapefiles; this function simply adds the shapefile map. If you would like to import shapefile properties as well; use the GIS/Tabular Import or GIS/Tabular Import and Update tools.

Note: To add a shapefile that includes sample data (which also needs to be added) use the GIS/Tabular Import and Update option in the File Menu.



2.6 GIS Recycle Bin

After you've imported shapefiles into PCASE 7, you may decide to delete some of those files. A list of your deleted shapefiles can be found in the GIS Recycle Bin; you can choose to permanently delete, or restore deleted files there.

2.7 GIS/Tabular Import and Update

The GIS/Tabular Import and Update options are similar to that of the GIS/Tabular Import, as previously mentioned these options have not been fully implemented for use with PCASE data import. You would use this option as opposed to the GIS/Tabular Import if you wish to add or update inventory data within an existing database. The main difference between both options is that the GIS/Tabular Import creates a new database prior to allowing you to import or update GIS/Tabular data. You can also access this tool from the Inventory menu.

2.7.1 Add Inventory from GIS/Tabular Data

Add inventory data from a GIS/Tabular report to the database you currently have open. Selecting this option invokes the Add New Inventory Items form to open, which is the same form described in section 2.1.2 GIS/Tabular Import.

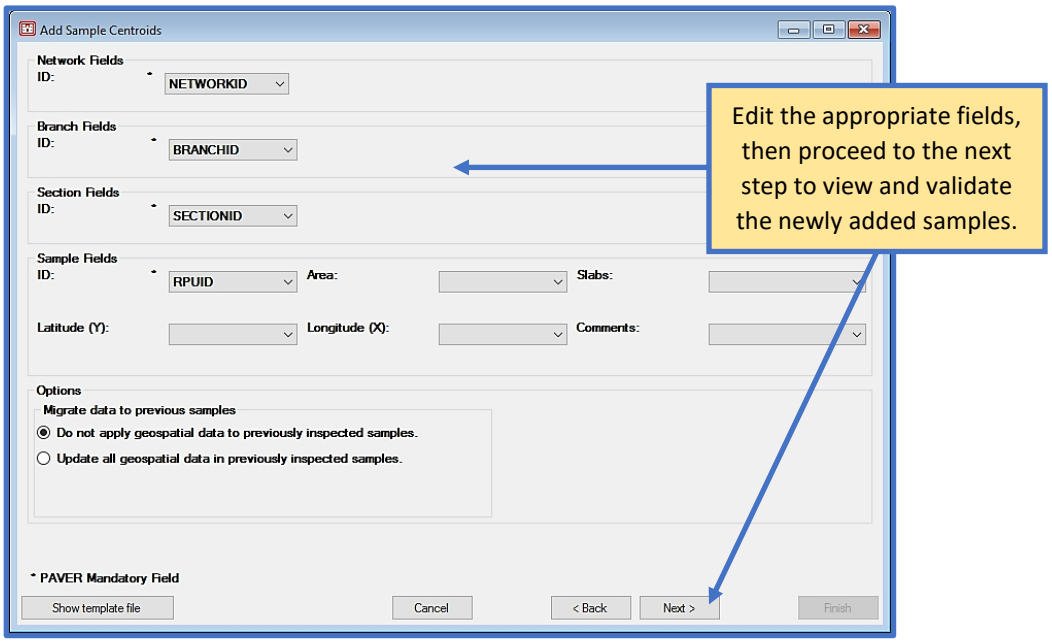
2.7.2 Update Inventory from GIS/Tabular Data

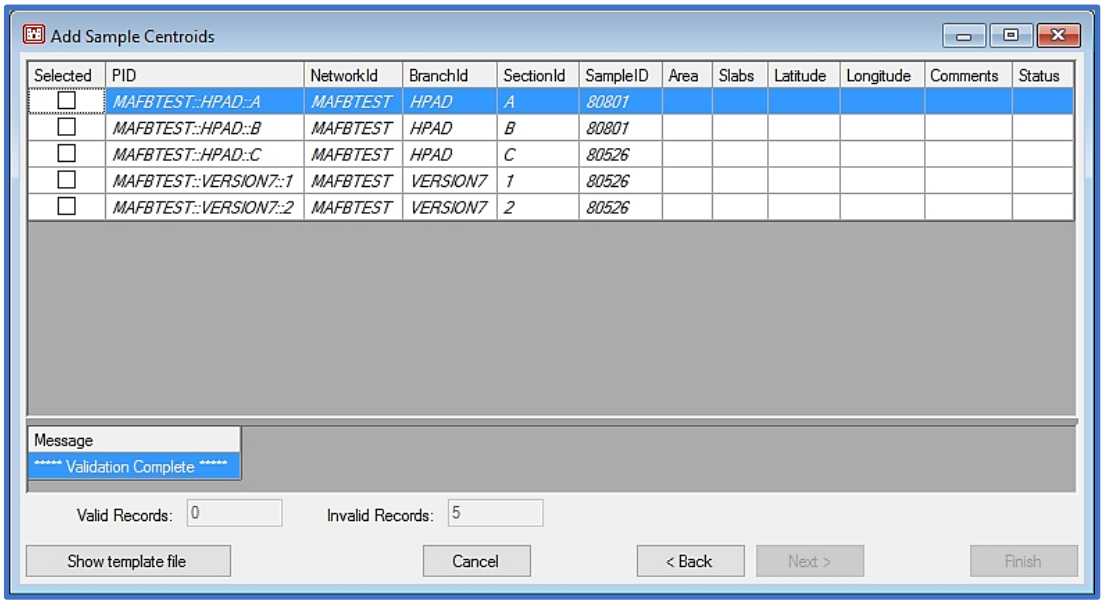
Update the current inventory within a database using a GIS/Tabular report.

2.7.3 Import Inventory Samples from GIS/Tabular Data

Import inventory samples from a GIS/Tabular report into a database. This process gives users the optional ability to have finer detailed tracking within Branches, and is most useful when a GIS map is also added.

The Add Sample Centroids form is arranged similarly to the Add New Inventory Items form. Choose an Inventory Data File to Import, then Browse to the file on your computer. Edit Source units if applicable, then select the Next button to proceed to the next step.

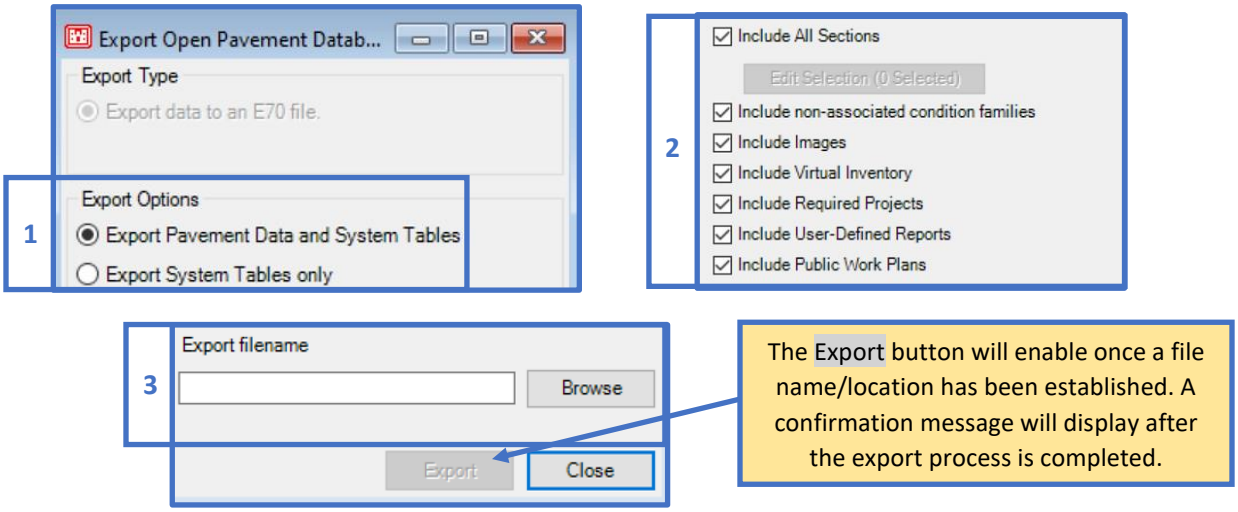




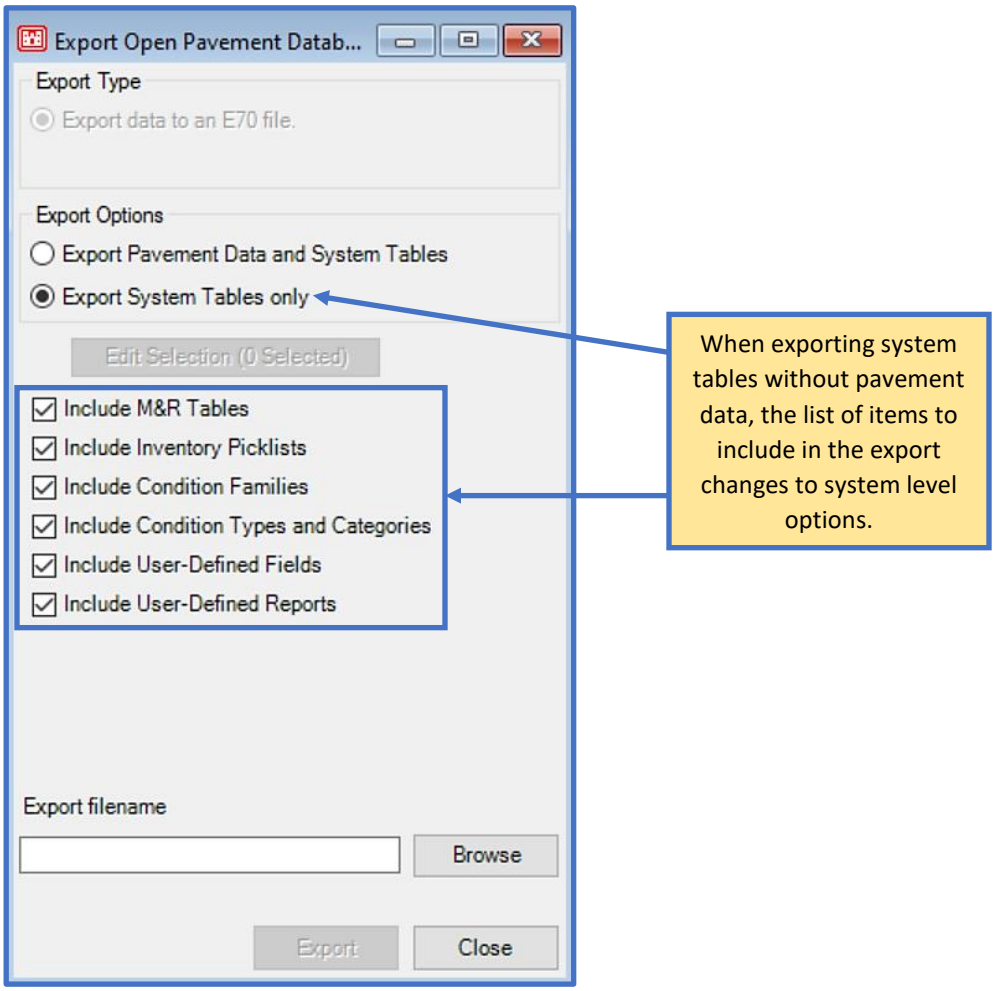
2.8 Export Open Pavement Database

Use the Export Open Pavement Database form to create an .e70 database file that you can share with others.

1. Export Pavement Data and System Tables is selected by default in the Export Options. Use this option if you would like to include the pavement data listed below the Export Options, as well as the system tables.
2. Un-check items from the list to exclude data you do not want to include in the export.
3. Browse to a location on your computer to store the exported .e70 file, give the .e70 a file name, then select Export.



If you would like to export system tables without pavement data, change Export Options to Export System Tables only. The list of items to include will change. Follow the same workflow as described above.

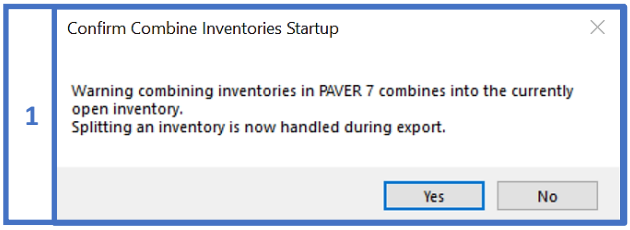


2.9 Combine Inventories

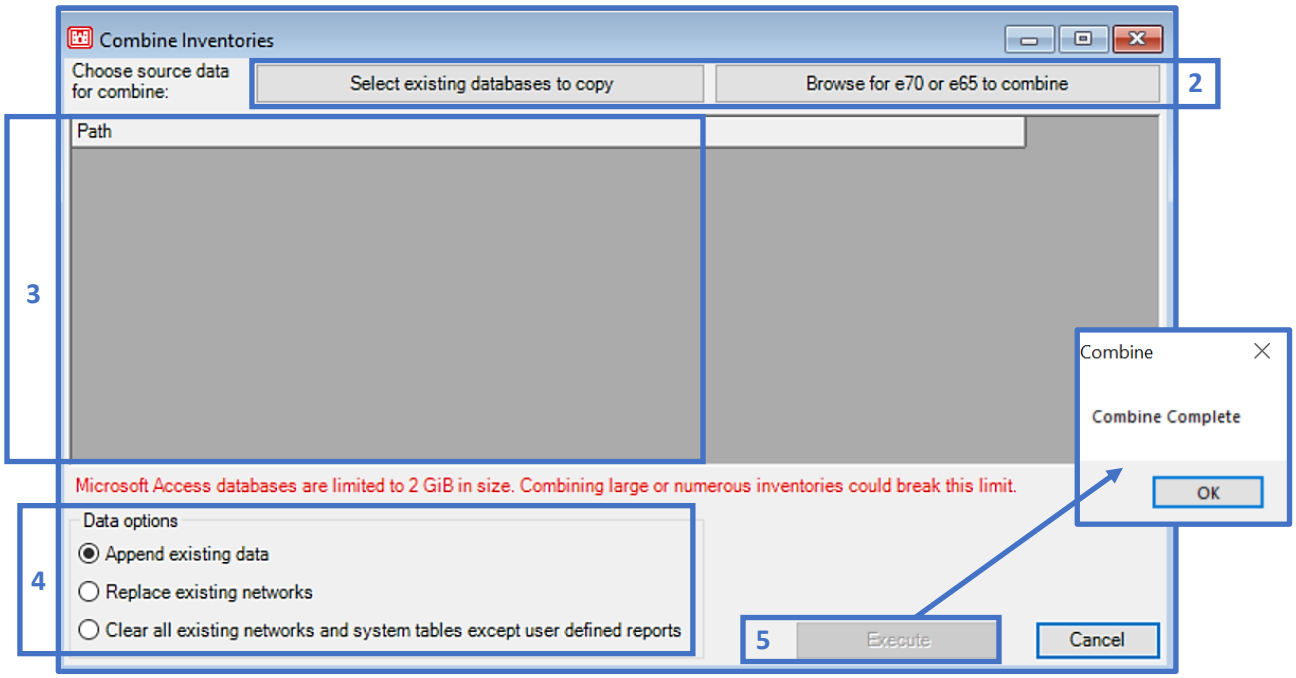
The Combine Inventories tool allows you to combine multiple databases or database segments into a single database. The database that is currently open in PCASE 7 is where the combined data will end up after the process has been completed. Before using this tool, create a new database to store the combined data in; following this procedure will result in a new database that contains the combined data and you'll still have the individual, uncombined databases as well.

Note: Microsoft Access databases are limited to 2 GB, using the combine process to combine large or numerous databases may break that limit.

1. Once you've created a new database to store your combined data in, proceed by selecting Yes if you are satisfied with combining data into the currently open database.

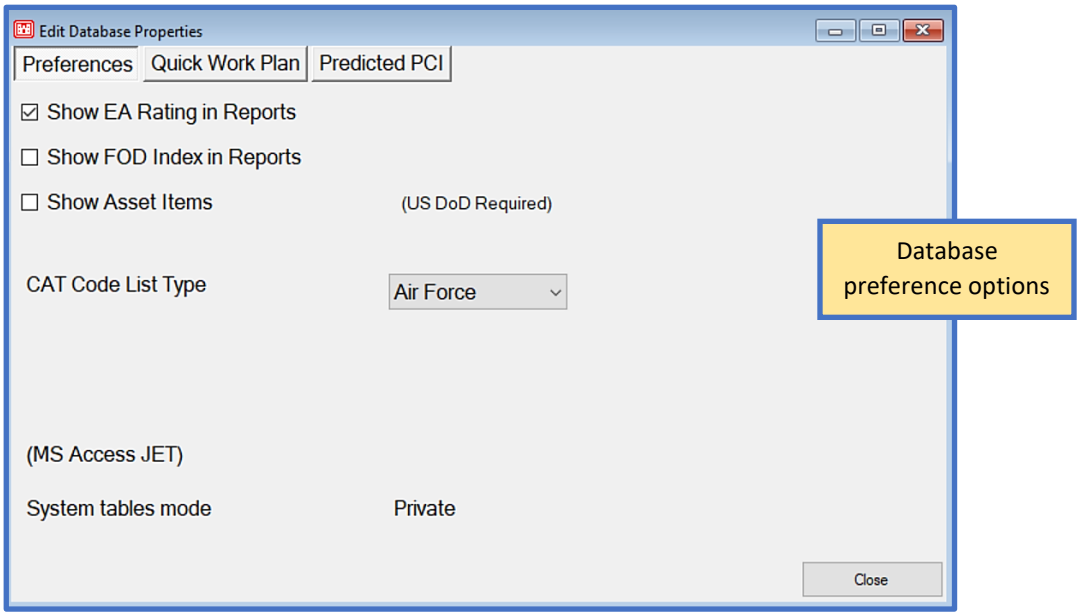


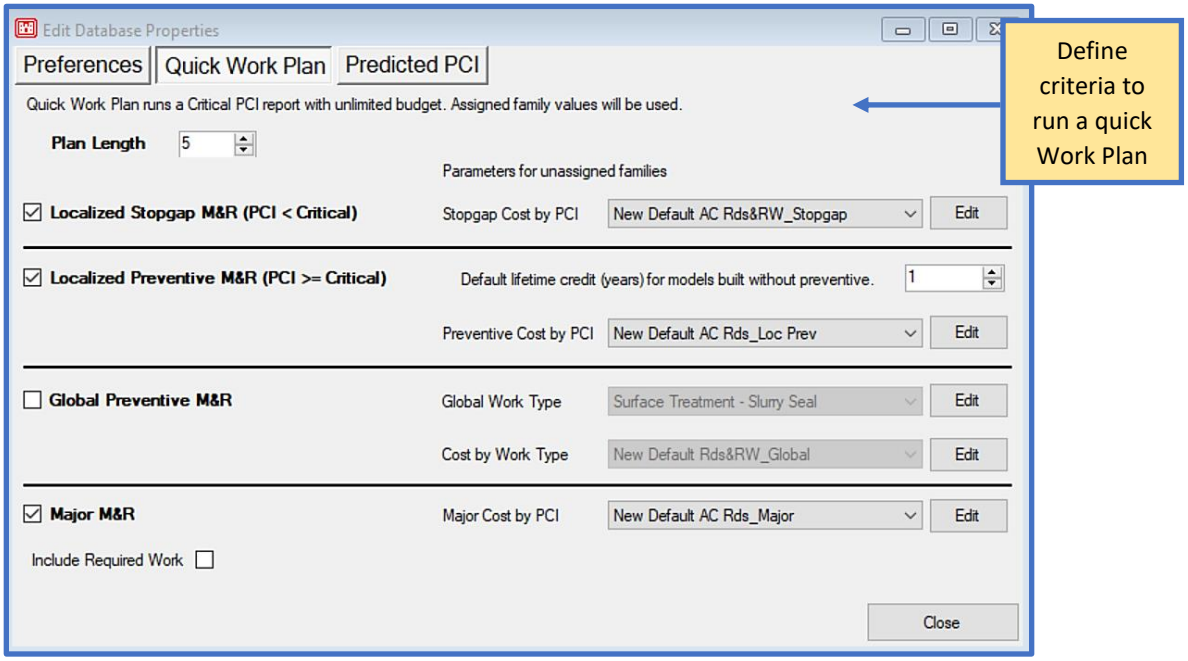
2. Select the method in which you would like to retrieve the source data for the combined database.
    - Choose the Select existing databases to copy button if you would like to copy data to use for the combine directly from the existing database, instead of using a previously exported .e70 of .e65.
    - Choose the Browse for e70 or e65 to combine button if you would like to select a previously exported .e70 or .e65 from a location on your computer.
3. After you've selected the databases to combine, their names will display in the Path section of the form.
4. Keep the default option to Append existing data, unless you would like to perform one of the actions listed below this option.
5. Select Execute to complete the combine process. A message will display to confirm the combine was successful.

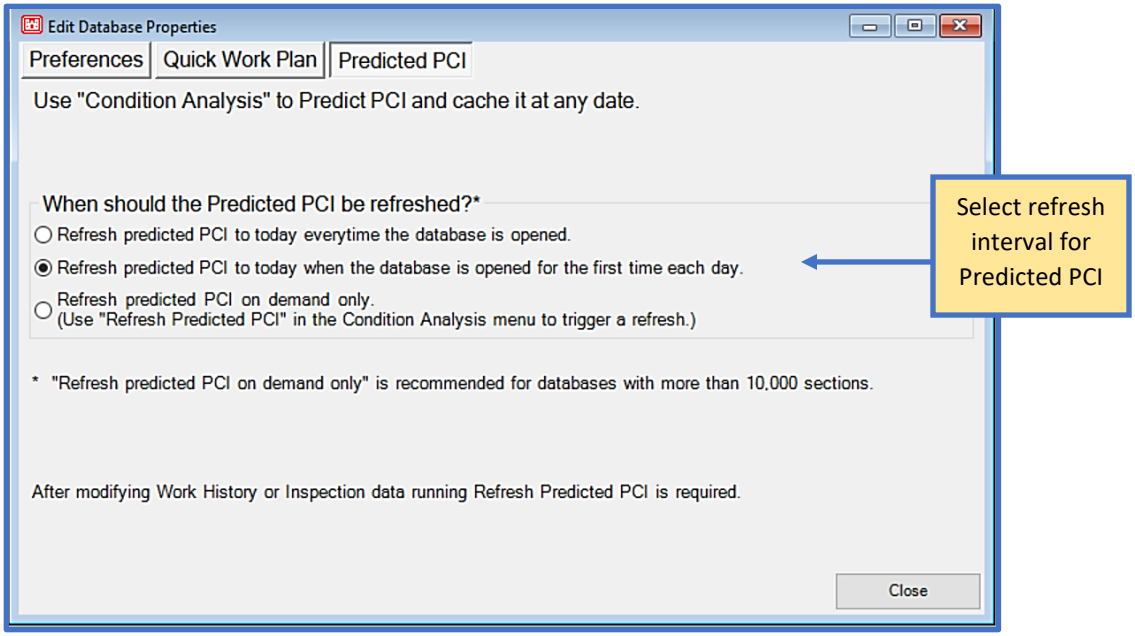


2.10 Database Properties

The Database Properties form consists of three tabs with settings for: Preferences, Quick Work Plan, and Predicted PCI. Settings that are changed within the Database Properties tab forms are database specific and will persist through the import/export operations.







2.11 Delete Pavement Database

The Delete Pavement Database tool allows you to select databases that have been previously opened in PCASE 7, deleted databases are moved to the Database Recycle Bin. Once you select one or more items from the list, the Delete selected items button will become enabled.

2.12 Database Recycle Bin

Databases that were deleted using the Delete Pavement Database tool will remain in the Database Recycle Bin until action is taken to either permanently delete, or restore the database(s). Select one or multiple databases from the Pavement Inventory Recycle Bin form to enable the Permanently Delete Selected Databases or Restore Selected Items buttons.

Note: Permanently deleted database files will be removed upon program start after 24 hours.

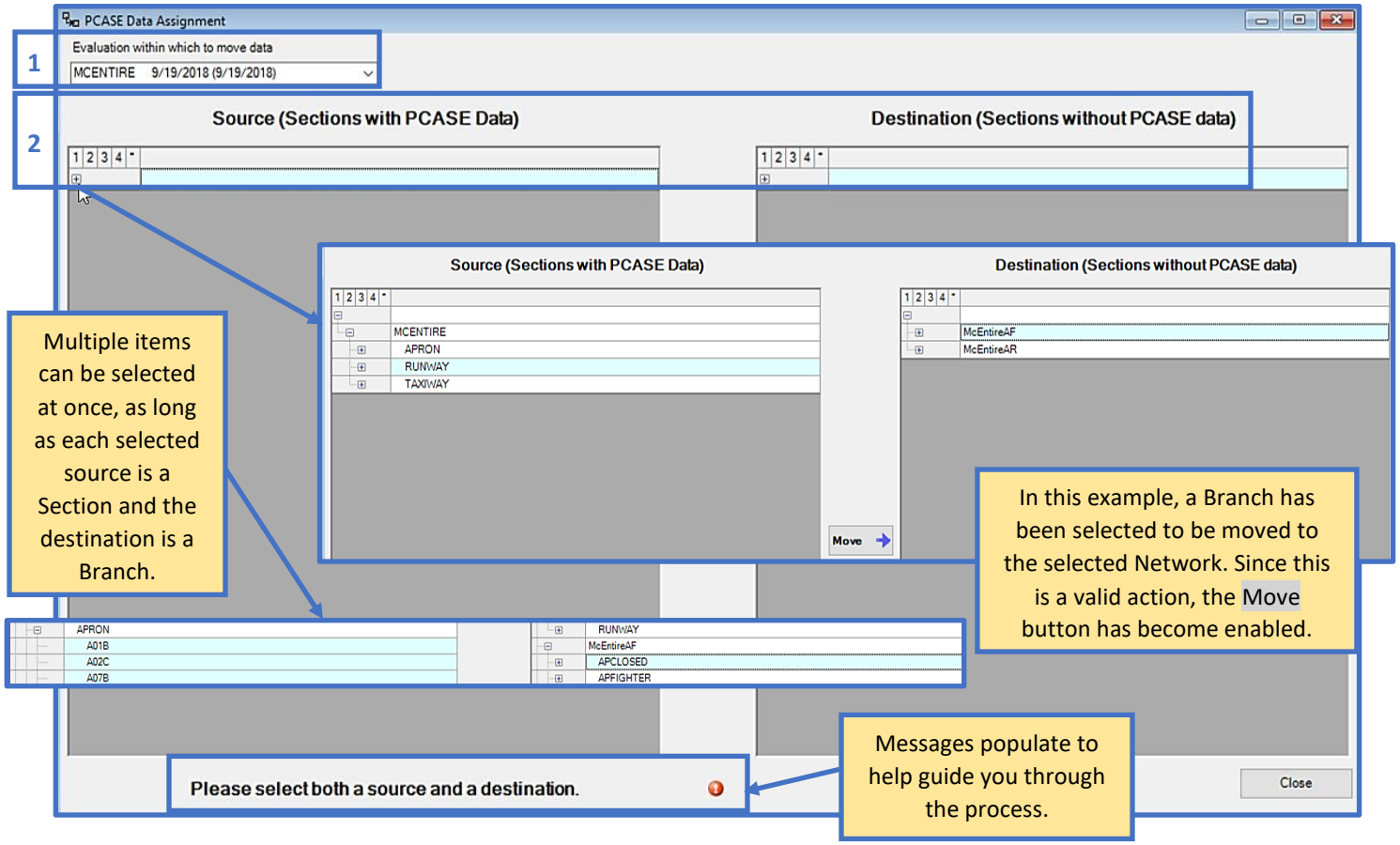
2.13 Combine or Import PCASE 209 Data

Select the Combine or Import PCASE 209 Data option to import PCASE 2.09 data into the currently open database. This operation's workflow is the same as when a new database is created with Import PCASE 209 data selected. See Step 5 in Section 2.1.1 for instructions on how to use the Combine or Import PCASE 209 Data tool.

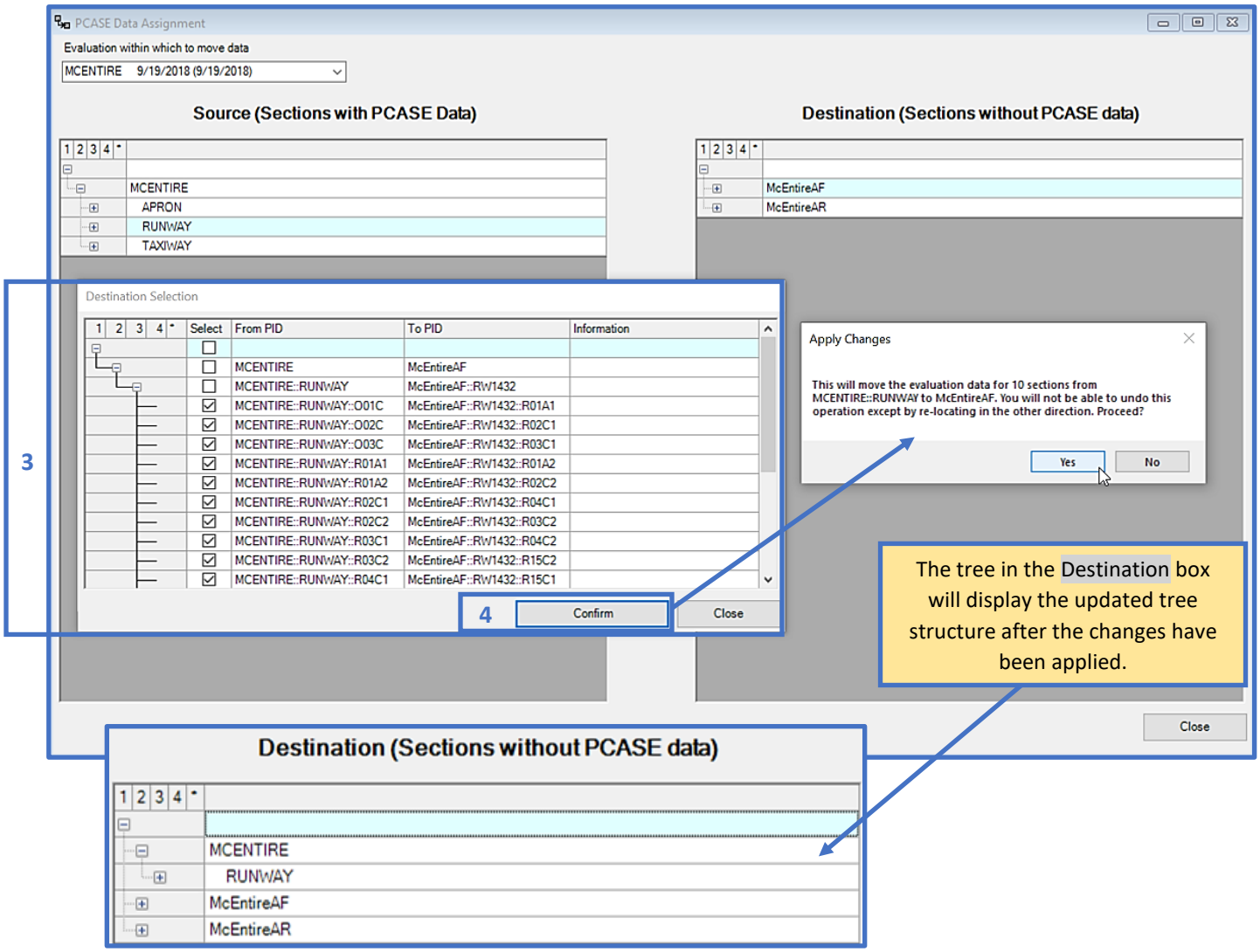
2.14 PCASE Data Assignment

Move Network, Branch, or Section data from within an evaluation using the PCASE Data Assignment tool. You can choose to move an entire Network from the Source box to another Network in the Destination box, or incrementally move Branches or Sections from Source to Destination.

1. Once the PCASE Data Assignment tool opens, the currently selected evaluation will be displayed within the Evaluation within which to move data drop-list. All evaluations that exist within the database you currently have open will be available in this drop-list as well. Ensure that you have the correct evaluation selected before you begin.
2. Click on the plus button to expand the grid tree nodes. Select a Network, Branch, or Section(s) from the tree in the Source box, then select the Destination to move your selection(s) to. If a selection is invalid, a message will display below the Source box explaining why the action could not be performed and the Move button will remain disabled until valid selections are made. Click on the Move button once you're satisfied with your selections.



3. The Destination Selection form will open after the move-data process has been executed, so you can view a summary of the data prior to completing the Move action.
4. Select the Confirm button if you're satisfied with the selections displayed. A final warning message will pop-up before the changes are applied.



2.15 Exit

The Exit option will close the PCASE 7 program, or you can click on the “x” in the top-right corner of the main window to exit the program.

3 System Tables and Tools

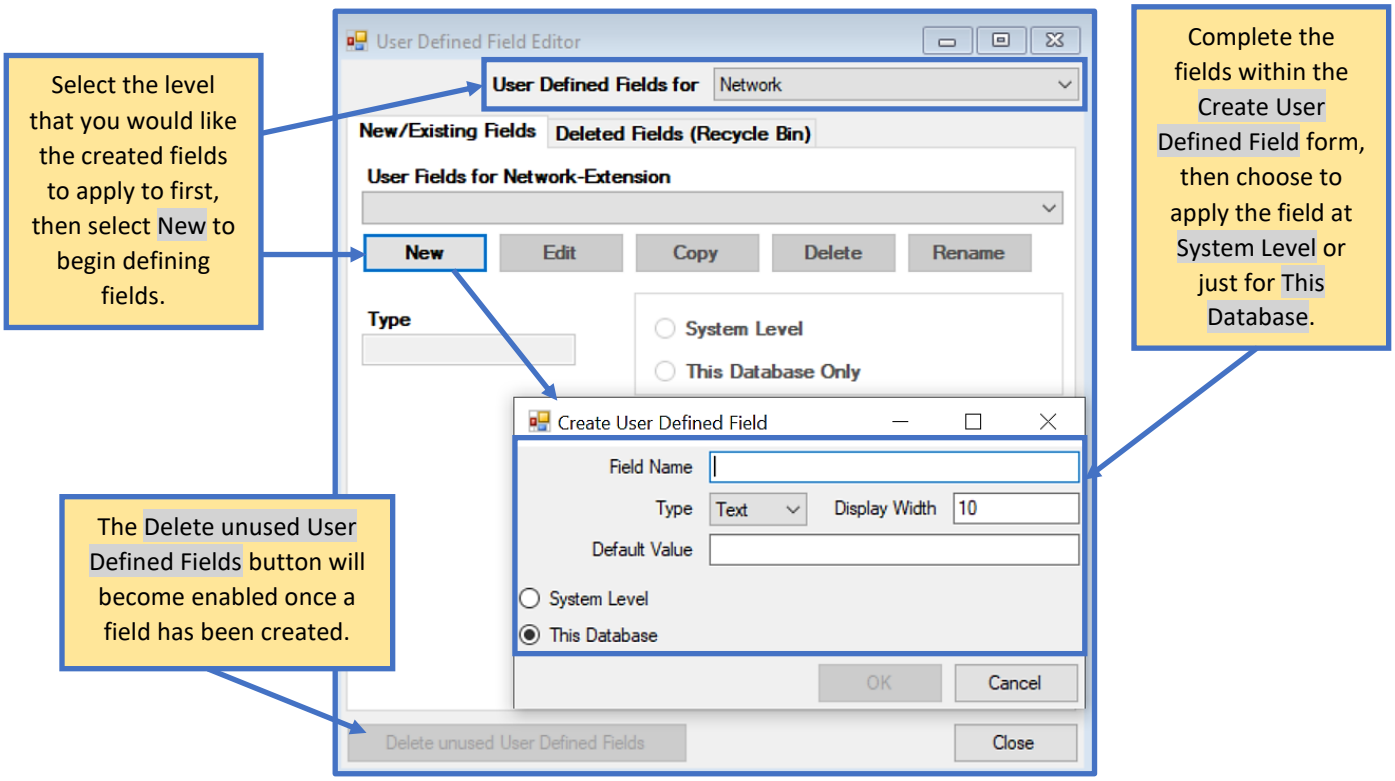
The System Tables and Tools menu consists of options for customizing and managing inventory fields/picklists. Tools related to vehicles, such as the Vehicle Editor, ACN/ACR Curves, and Import User Defined Vehicles can be found within the Vehicles menu.

3.1 User Defined Inventory Fields

The inventory system is designed so that users may assign user-defined fields to each level of the inventory (Network, Branch, and Section). Doing so allows sorting of the database at any level, according to the criteria you have defined. The fields you create will automatically display within the coinciding inventory form tab in the User defined fields section.

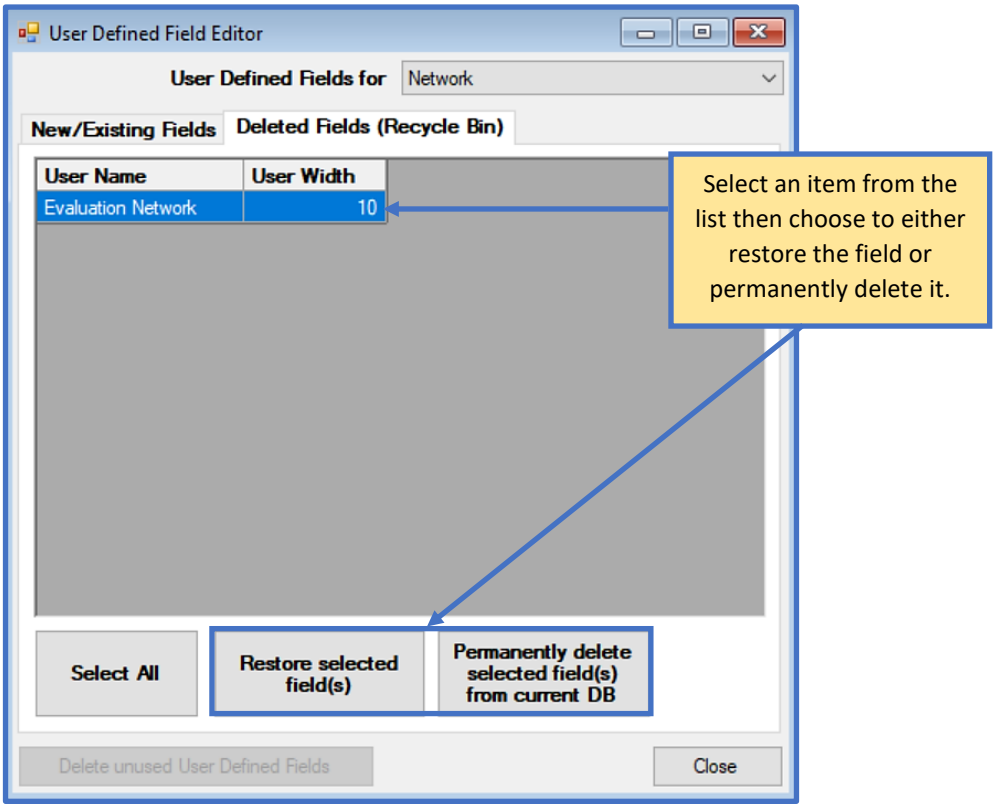
3.1.1 New/Existing Fields

The User Defined Field Editor form contains two tabs; New/Existing Fields for creating and managing defined fields and Delete Fields (Recycle Bin), which can be used to permanently delete or restore deleted fields.



3.1.2 Delete Fields (Recycle Bin)

Any fields that you opted to delete within the New/Existing Fields tab will be listed in the table. Use the buttons below the table to choose what you would like to do with deleted fields.



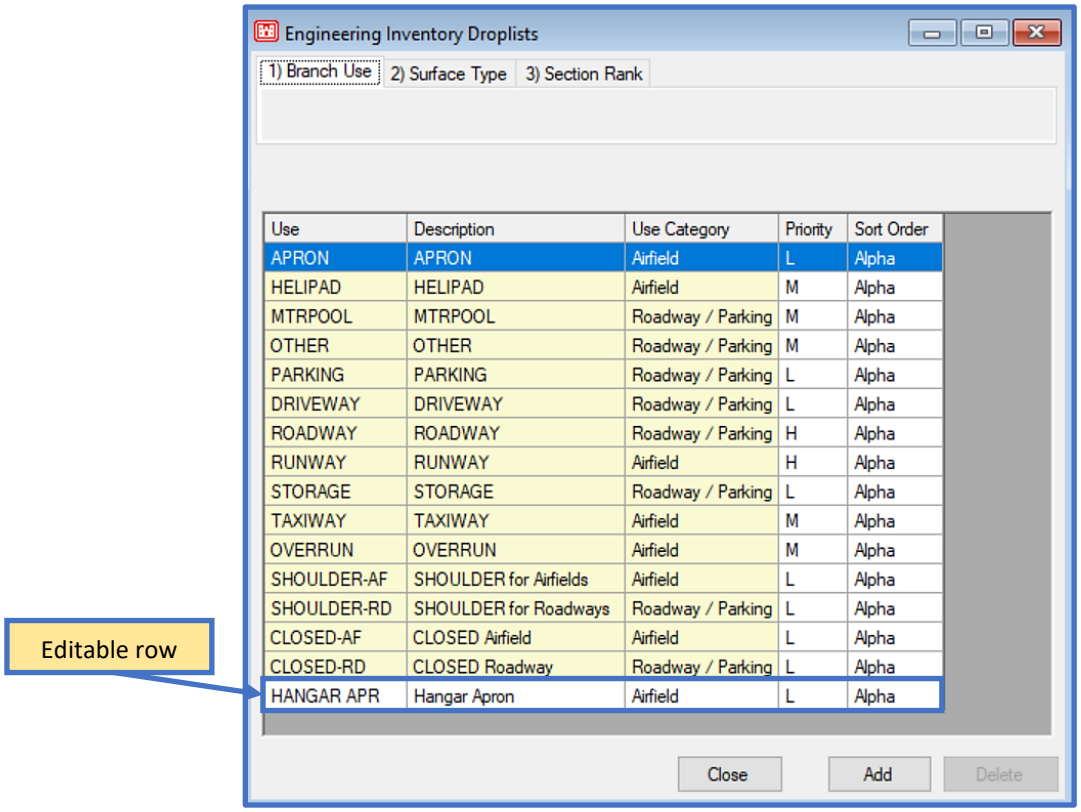
3.2 Edit Inventory Picklists

There are two field customizing options for inventory picklists, which are grouped by engineering terms or descriptive fields for use within the program. To add fields related to Branch Use, Surface Type, or Section Rank; select the Engineering Fields option. Select Descriptive Fields to add fields which correlate to Zone, Section Category, Shoulder, or Street Type. *Note: If you have Show Asset Items turned on (File > Database Properties > Preferences) additional category tabs will be displayed including FAC, CATCD, Site, and Facility.*

3.2.1 Engineering Fields

Select the tab category you would like to add a new field to. You may also edit existing fields that are listed in the grid rows, as long as the cell row is not colored yellow (yellow cells are read-only to prevent editing required fields). Click on the Add button to populate a new, editable row in the grid.

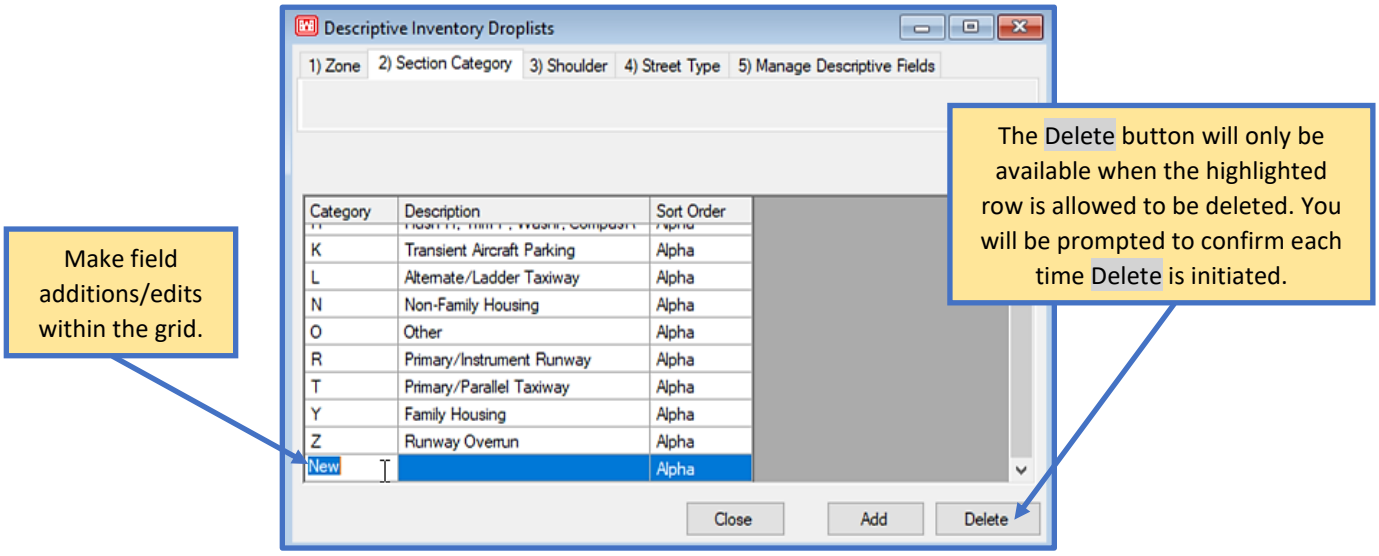
New rows will automatically populate at the bottom of the grid by default. Sort columns by clicking on the column headers or assigning a Sort Order to fields.



Use	Description	Use Category	Priority	Sort Order
APRON	APRON	Airfield	L	Alpha
HELIPAD	HELIPAD	Airfield	M	Alpha
MTRPOOL	MTRPOOL	Roadway / Parking	M	Alpha
OTHER	OTHER	Roadway / Parking	M	Alpha
PARKING	PARKING	Roadway / Parking	L	Alpha
DRIVEWAY	DRIVEWAY	Roadway / Parking	L	Alpha
ROADWAY	ROADWAY	Roadway / Parking	H	Alpha
RUNWAY	RUNWAY	Airfield	H	Alpha
STORAGE	STORAGE	Roadway / Parking	L	Alpha
TAXIWAY	TAXIWAY	Airfield	M	Alpha
OVERRUN	OVERRUN	Airfield	M	Alpha
SHOULDER-AF	SHOULDER for Airfields	Airfield	L	Alpha
SHOULDER-RD	SHOULDER for Roadways	Roadway / Parking	L	Alpha
CLOSED-AF	CLOSED Airfield	Airfield	L	Alpha
CLOSED-RD	CLOSED Roadway	Roadway / Parking	L	Alpha
HANGAR APR	Hangar Apron	Airfield	L	Alpha

3.2.2 Descriptive Fields

The Descriptive Inventory Droplists form works in the same manner as the Engineering Inventory Droplists form. Select the Add button to populate a row to input information.



Category	Description	Sort Order
K	Transient Aircraft Parking	Alpha
L	Alternate/Ladder Taxiway	Alpha
N	Non-Family Housing	Alpha
O	Other	Alpha
R	Primary/Instrument Runway	Alpha
T	Primary/Parallel Taxiway	Alpha
Y	Family Housing	Alpha
Z	Runway Overrun	Alpha
New		Alpha

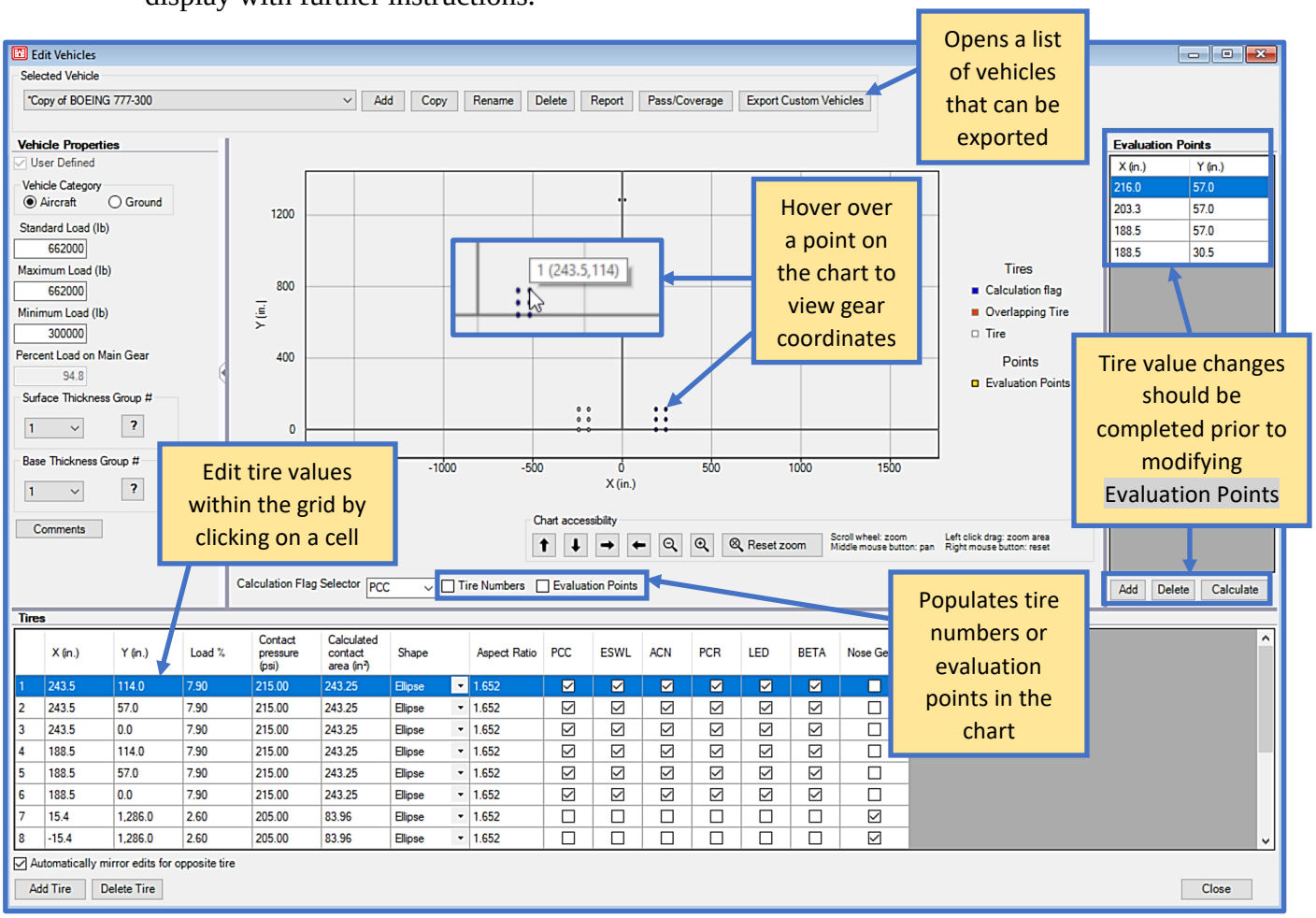
3.3 Vehicles

The tools that are available in the Vehicles section pertain to different types of vehicle criteria. The Vehicle Editor can be used to make copies of existing vehicles from the database to modify characteristics of, or to create new custom vehicles; both of which can then be used for designs and/or evaluations. The ACN/ACR Curves tool is used to view and calculate ACN/ACR values. A vehicles database (MDB file) can be imported into PCASE 7 using the Import User Defined Vehicles tool.

3.3.1 Vehicle Editor

Select a vehicle from the Selected Vehicle drop-list if you would like to modify vehicle characteristics for an existing vehicle, then click on the Copy button to create an editable version of that vehicle. If you wish to create a new vehicle, skip to the next page.

The copied vehicle can now be edited, note that the areas of the form that were once colored gray (read-only or disabled) are now enabled. To prevent modification of standard vehicles in the database, the form only allows edits to custom vehicles. Changes made to the form are automatically saved after the form is closed. However, if the vehicle is left in an invalid state when you attempt to close the form, a warning message will display with further instructions.



Before creating a new vehicle using the Vehicle Editor; you must first obtain the vehicle information identified in the tables below from the vehicle manufacturer.

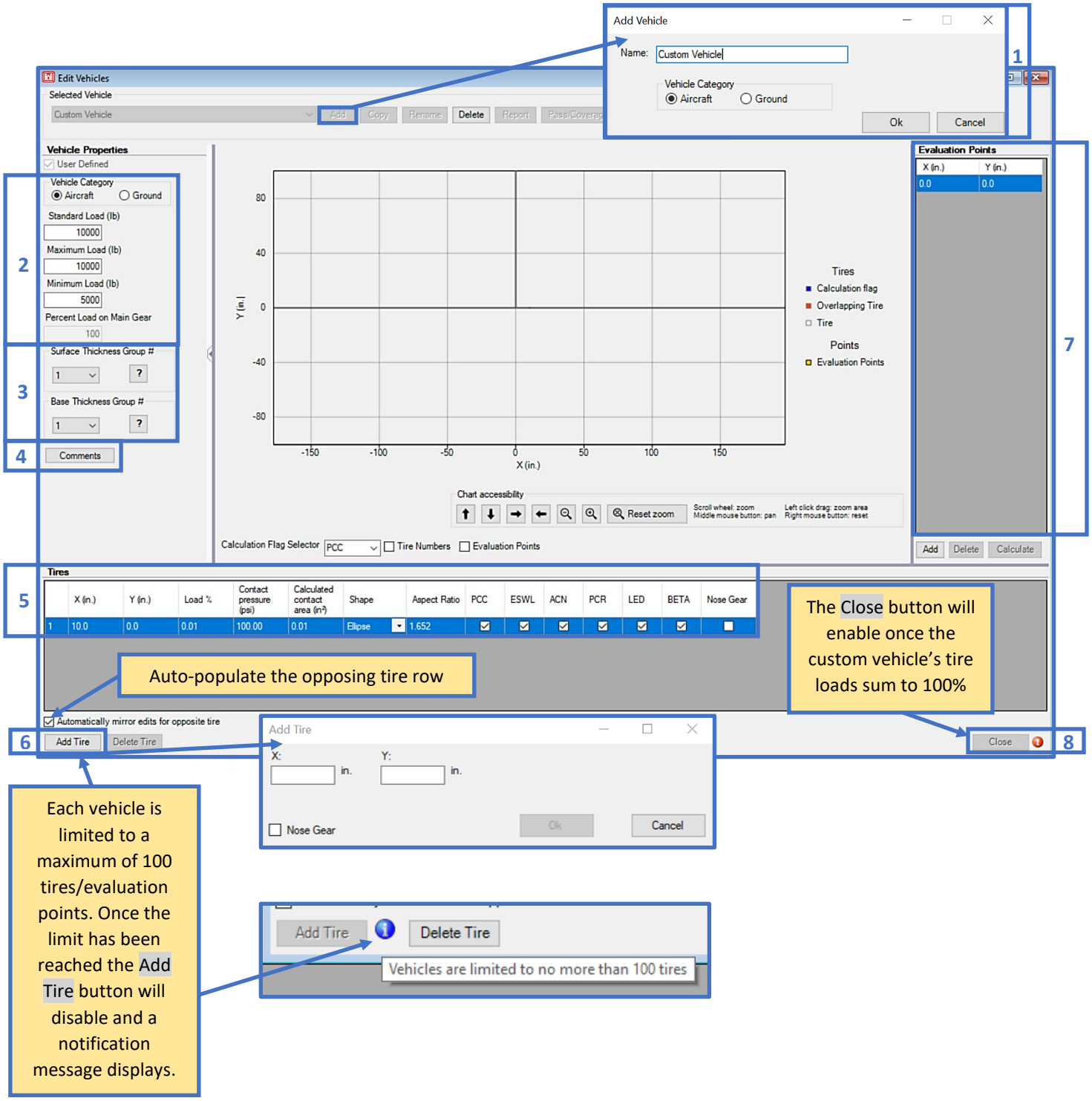
Vehicle Information	
Name of Vehicle	
Standard Load (lbs)	
Maximum Load (lbs)	
Minimum Load (lbs)	
Surface Thickness Group #	
Base Thickness Group #	

Tire Number	X-coordinate (in)	Y-coordinate (in)	Load %	Tire Pressure (psi)	Contact Area (in^2)	Tire Shape
1						
2						
3						
4						
Etc.						

Once you've obtained the required above information, click on the Add button to begin inputting vehicle data.

1. The Add Vehicle form opens after selecting Add. Input a Name and select a Vehicle Category.
2. In the Vehicle Properties section, edit the vehicle's Standard Load, Maximum Load, and Minimum Load values. *Note: The minimum/maximum load information should come from the vehicle manufacturer. Standard load information is Service-specific.*
3. Choose the vehicle Surface Thickness Group # and Base Thickness Group #. Click on the info icons if you need guidance in selecting group #'s. *Note: If you do not know this information, reference a similar vehicle's group #'s.*
4. Add Comments about the vehicle, if so desired.
5. The first row in the Tires grid auto-populates upon custom vehicle creation with default values; edit these values within the grid cells. Validation logic within the Tires grid will notify you of invalid values and what the acceptable range is in some cases.

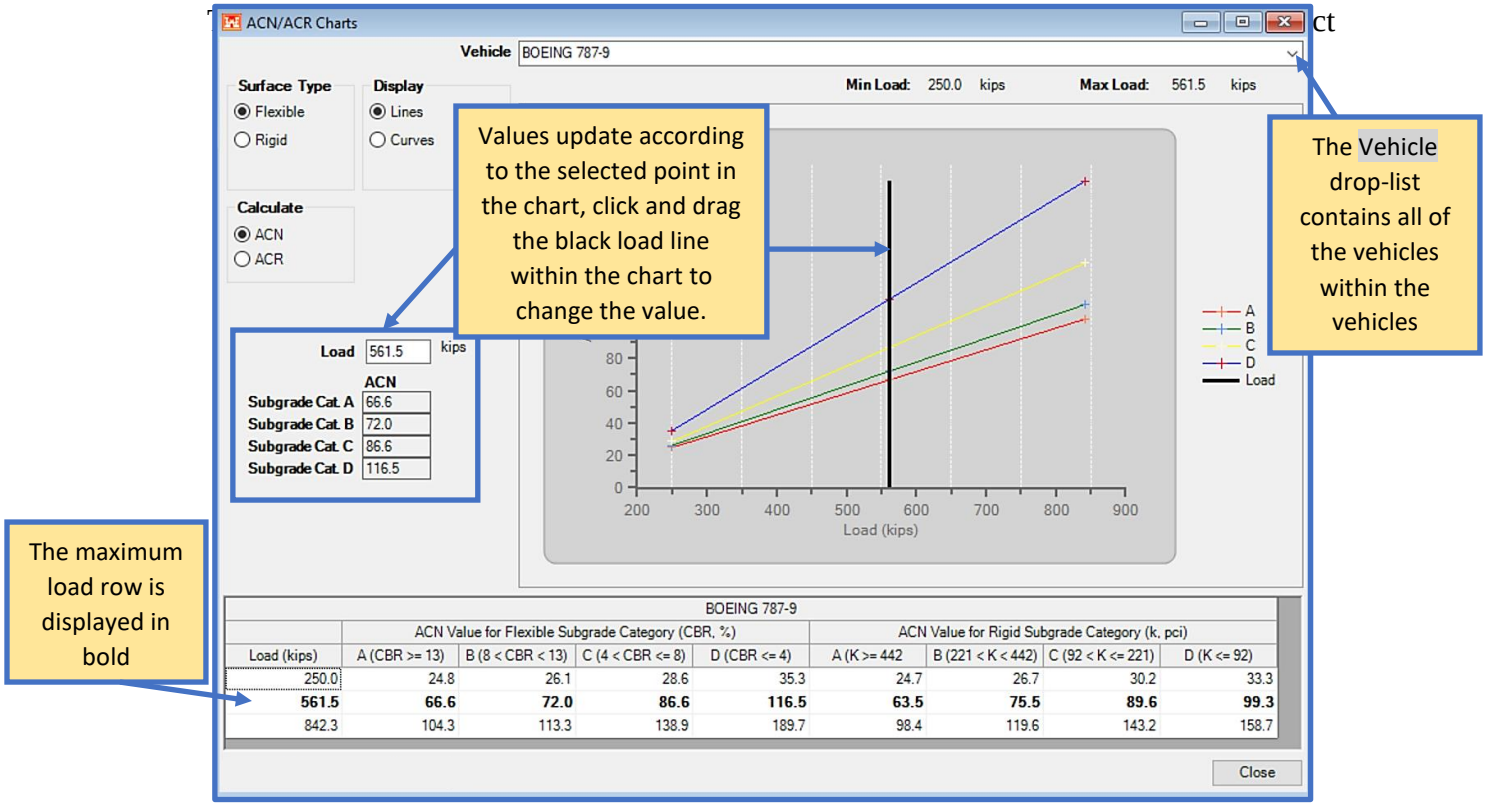
6. Click on the Add Tire button to input information for each additional tire. Be sure to complete all column fields before proceeding with adding the next tire.
7. Add Evaluation Points for each tire. Once each tire has Evaluation Points assigned, click on the Calculate button.
8. Close the form to save the new vehicle to the Custom Vehicles folder on your computer. Your new custom vehicle will now be available for use in PCASE 7.



3.3.2 ACN/ACR Curves

The ACN/ACR charts form can be accessed from the System Tables and Tools menu, or from the Traffic form within the Design, APE and LEEP modules.

Note: The ACN is the current international Civil Aviation Organization (ICAO) procedure for reporting pavement strength and the ACR is the new ICAO procedure that will be implemented in 2023 by member nations. The Department of Defense has not set an implementation date.

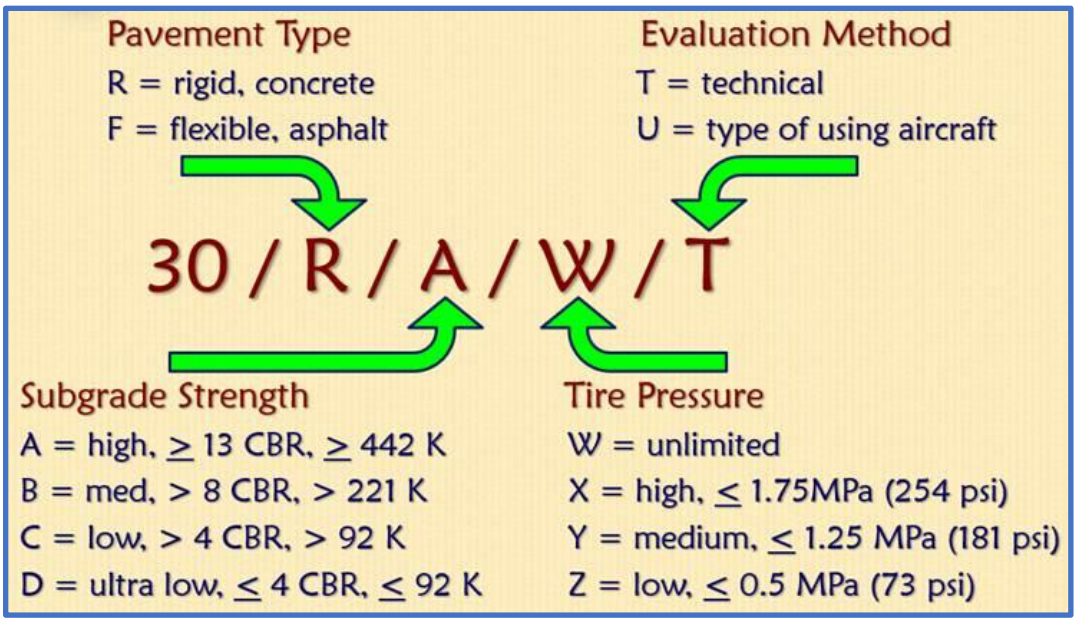


on an aircraft of a given weight on a pavement structure, for a specified standard subgrade strength – in terms of a standard single-wheel load. The Pavement Classification Number (PCN) is a number (five-part code shown in the image below) that expresses the load capability of a pavement based on aircraft type, pass level, and subgrade strength – in terms of a standard single-wheel load.

By comparing the ACN of a specific aircraft to the PCN of a pavement section, one can determine whether the aircraft can safely operate at a specified weight on the pavement section. PCASE 7 implements the Civil Aviation Organization (ICAO) guidance for computing ACNs and PCNs when doing pavement evaluations. There is an ongoing ICAO effort to transition from the ACN/PCN system to the Aircraft Classification Rating (ACR) and Pavement Classification Rating (PCR) system. The objective of transitioning to the new system is the same as the ACN/PCN system, but it addresses some of the perceived shortfall of the ACN/PCN system. Specifically, it takes a more mechanistic approach to the computation by using a stress-strain response. All wheels are considered

rather than a standard single-wheel load, and the new approach uses modulus and Poisson's Ratio material properties, rather than CBR and Modulus of Subgrade Reaction (k) values (Indexes) used in the ACN/PCN procedure.

The new ACR procedure has been implemented in PCASE 7. However, the Department of Defense has not yet set a date for adopting the new ACR/PCR procedure.

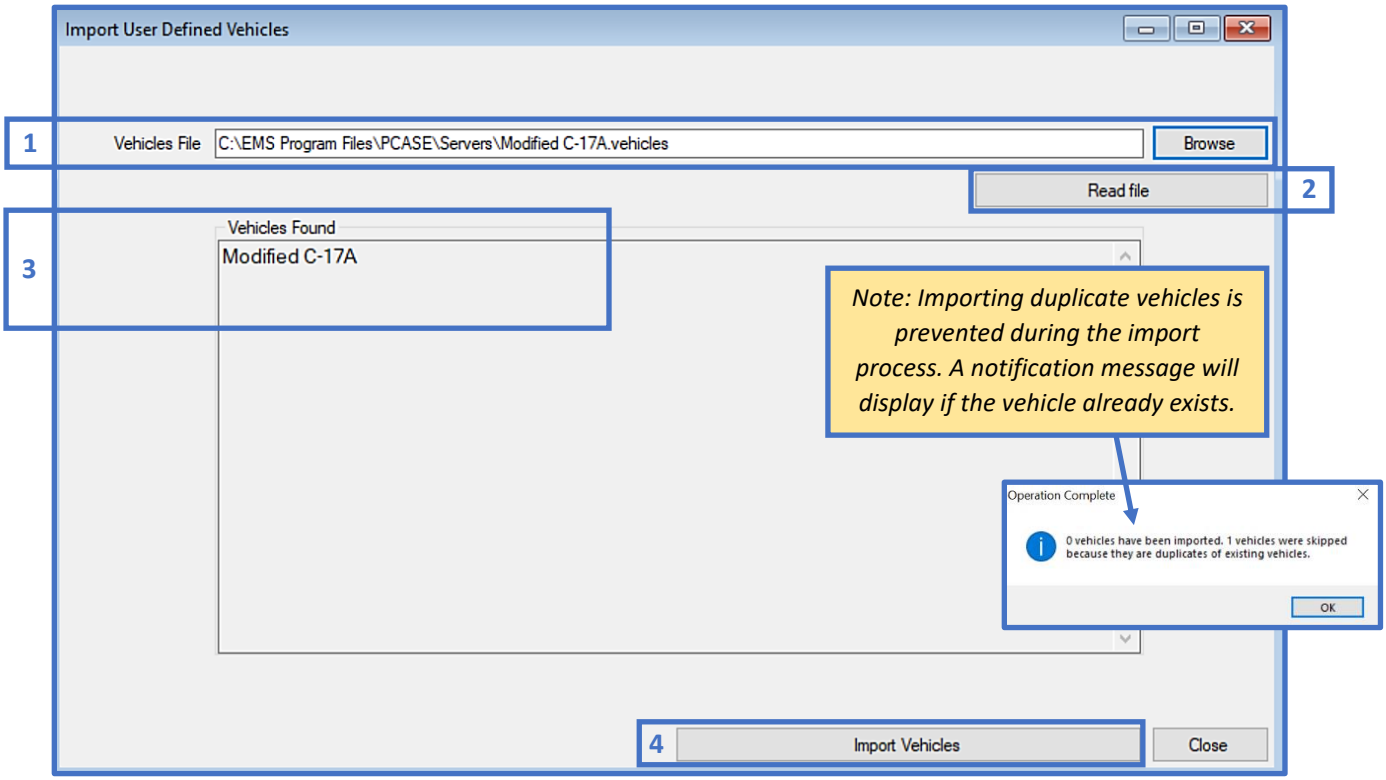


3.3.3 Import User Defined Vehicles

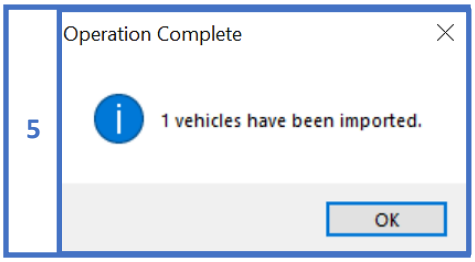
Import custom vehicles from a PCASE 2.09 or PCASE 7 vehicles database on your computer using the Import User Defined Vehicles tool. Before you begin, ensure that the vehicles.mdb file containing the custom vehicles you would like to import are accessible from your computer.

1. The default vehicles database storage location on your computer when PCASE is installed auto-populates within the Vehicles File field. If the actual location of the vehicles database is different than the file path displayed in this field, Browse to the correct file location. Once the correct vehicles.mdb file path has been established, proceed to Step 2.
2. Click on the Read file button.
3. During this process, PCASE 7 searches for custom vehicles within the vehicles database and populates those vehicles in the Vehicles Found box below.

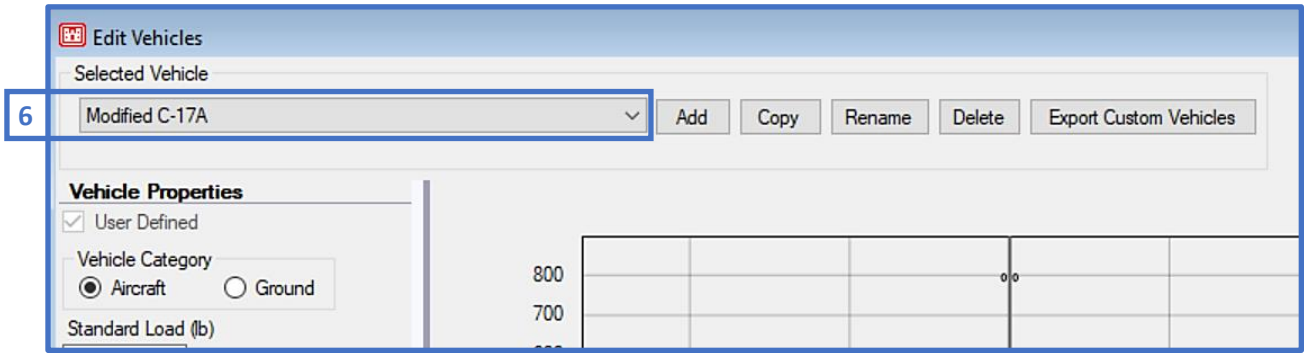
4. The Import Vehicles button becomes enabled once custom vehicles have been identified. Select the Import Vehicles button to continue.



5. A confirmation message will display once the import process is successful.

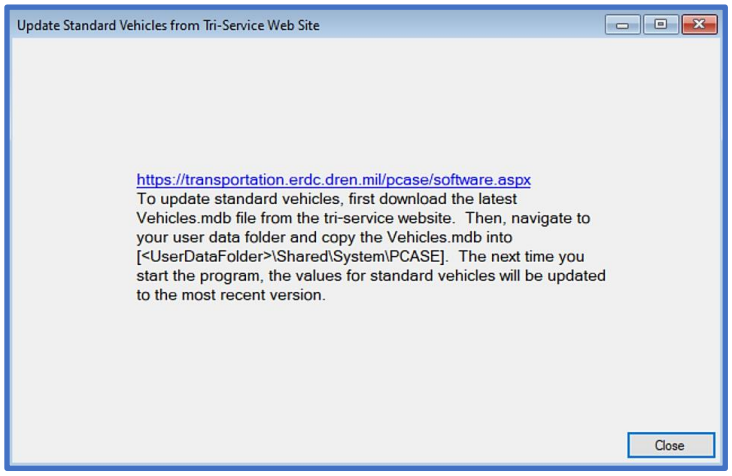


6. The imported vehicle(s) will now be available for use in PCASE 7. To verify the vehicle(s) were imported successfully, open the Vehicle Editor and search for the vehicle in the Selected Vehicle list.



3.3.4 Update Standard Vehicles

A link to the most current standard vehicles database is provided in the Update Standard Vehicles from Tri-Service Web Site window. Instructions on completing the update are provided below the link.



4 User Preferences

PCASE 7 preference options consist of Units settings, window view settings, default settings, and GPS settings. These settings apply to the entire program, unless specified otherwise. Changes made within the Menus and PCASE Defaults tabs require a program restart to take effect.

4.1 English Units

The default Units setting in PCASE 7 is English Units. Click on a Units option to change it. Changes to this setting will affect the entire program.

4.2 Metric Units

Click on Metric Units to switch from English to Metric. Changes to this setting will affect the entire program.

4.3 EMS Desktop

The EMS Desktop view is the default setting in PCASE 7. All forms open within the main PCASE 7 program window and cannot be moved outside of the window. Multiple forms can be open at the same time and overlap each other. The most recently opened form, is positioned in front of the previously opened form. Clicking on any open form will bring it forward.

4.4 Windows Desktop

Switch to the Windows Desktop view by clicking on this option in the menu. Move any open form outside of the main PCASE 7 window using this option, the independent form positioning allows you to view various forms on multiple monitors.

4.5 Language

Currently the only available Language option is English. Additional languages may be added in the future.

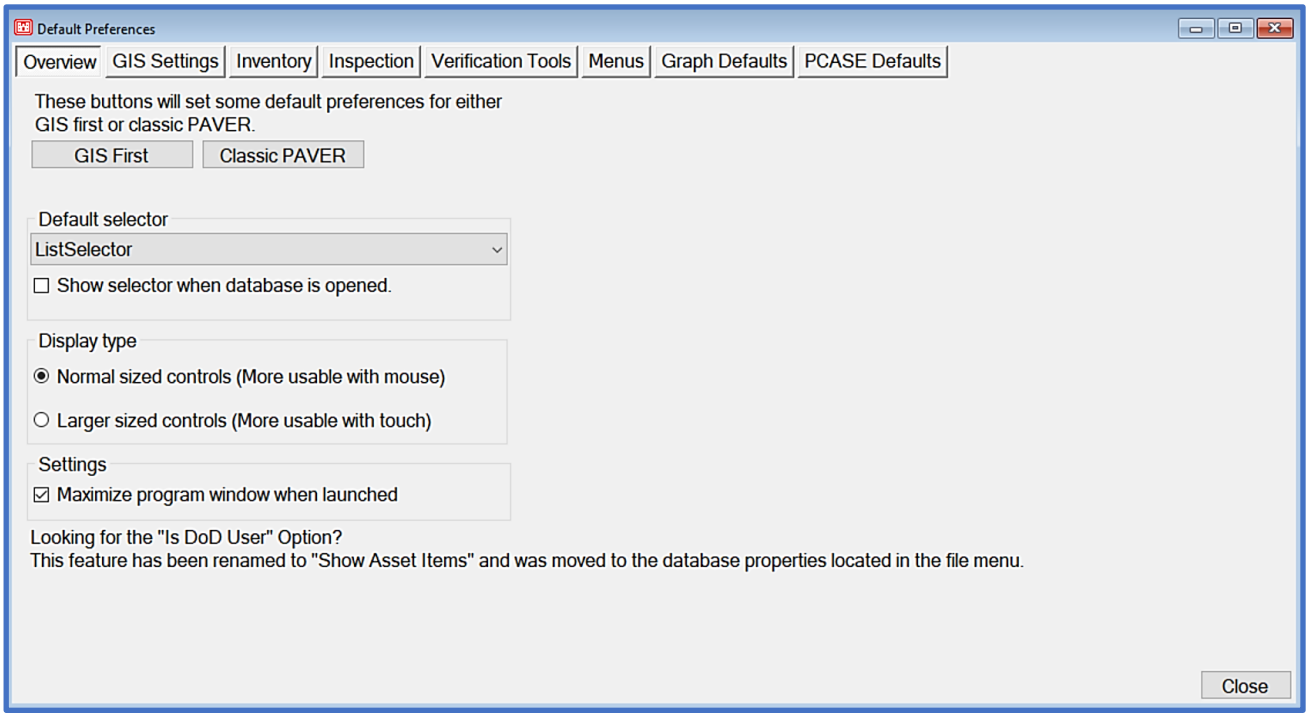
4.6 Defaults

The majority of the options within the Default Preferences form tabs contain default settings to control how certain aspects of the user interface are presented. In addition, PCASE Defaults has preference options for Design and Evaluation criteria such as Moduli, Service, and analysis defaults for global application.

4.6.1 Overview

The Overview tab consists of options for displaying selectors and controls.

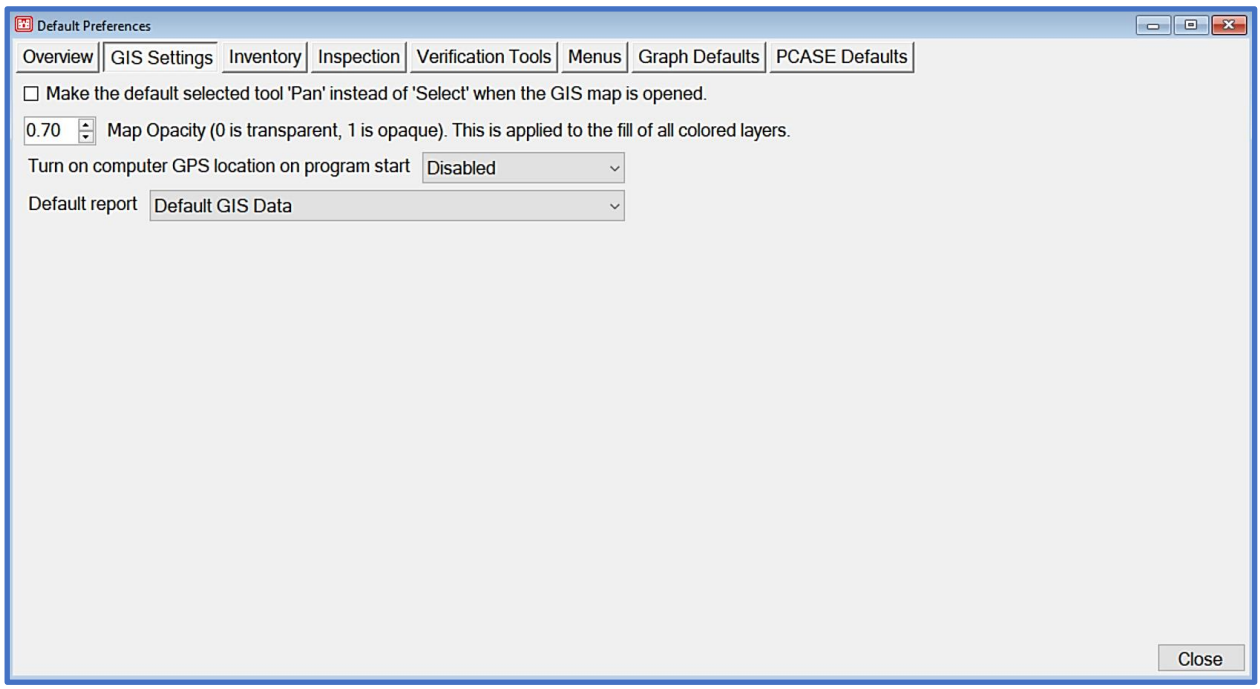
- GIS First will make GIS Selector the Default selector. Additionally, when PCASE 7 is restarted the GIS Selector and map will automatically open, if there is a PAVER™ inventory in the current database. Classic PAVER reverts back to the Default selector, which is the List Selector and the next time PCASE 7 is opened the window will open as normal.
- The Default selector allows you to manually choose the selector that will open when using a selector is applicable within the program. Select the Show selector when database is opened checkbox if you would like the chosen selector to launch upon program start.
- The Display type options are useful for enlarging control visibility when in tablet mode on your computer.
- The main PCASE 7 program window opens slightly minimized by default. Select the Maximize program window when launched option if you would like the program to open with the main window maximized by default, the next time you open PCASE 7.



4.6.2 GIS Settings

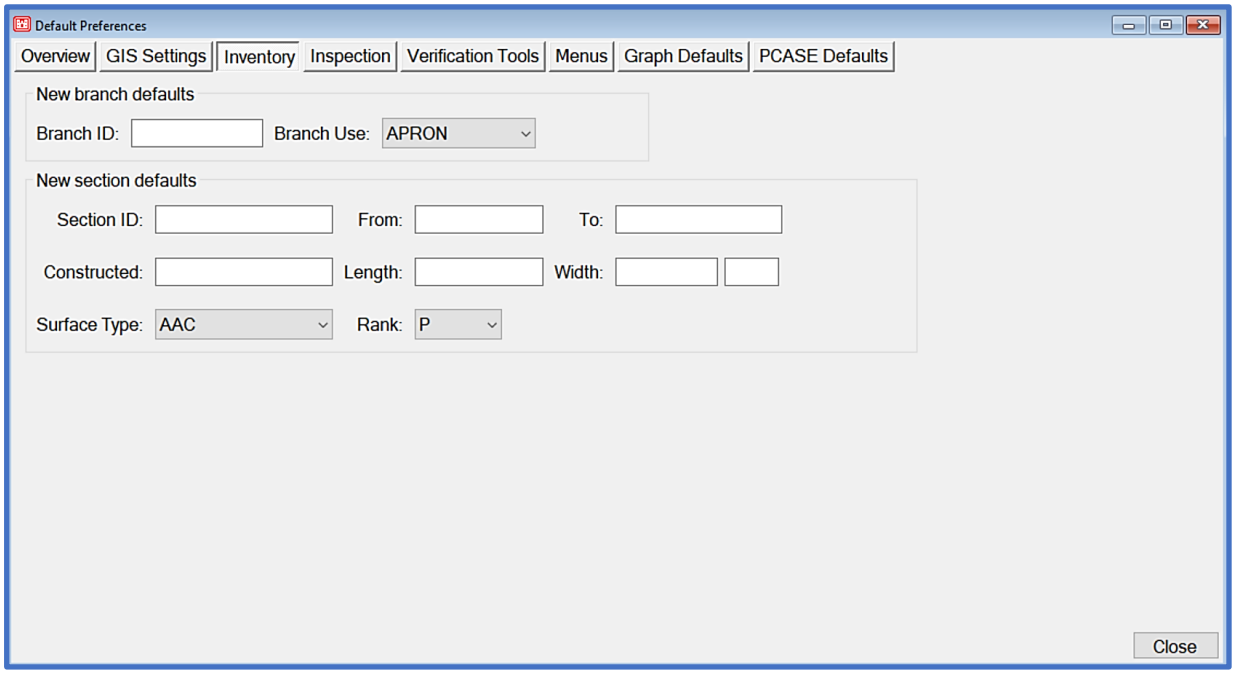
The GIS Settings tab pertains to GIS map function defaults.

- The first option in this tab can be used to set the GIS map to pan when hovering over the map, meaning you can scroll over areas of the map without selecting sections/areas. You can override this default within the form to allow areas of a GIS map to be selected. Normally the GIS map is set to select by default.
- The next option allows you to control the level of opacity for colored layers within a GIS map. Lower the value to increase transparency or raise the value to increase opacity.
- GPS location is set to Disabled by default. Set this option to Enabled if you would like GPS to be turned on by default when the program is launched.
- The Default report option allows you to set a default report format from previously memorized User Defined Reports.



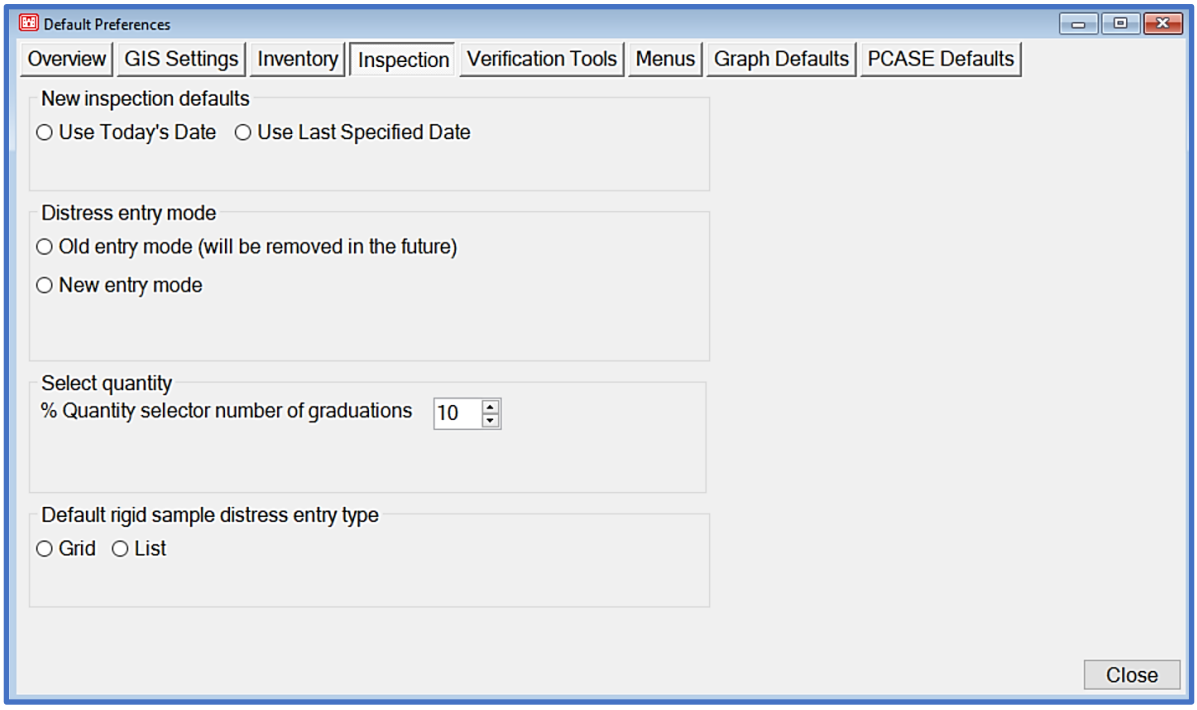
4.6.3 Inventory

The Inventory tab offers options to set default values for PAVER™ inventory Branches and Sections. These default values auto-populate during new Branch and Section creation.



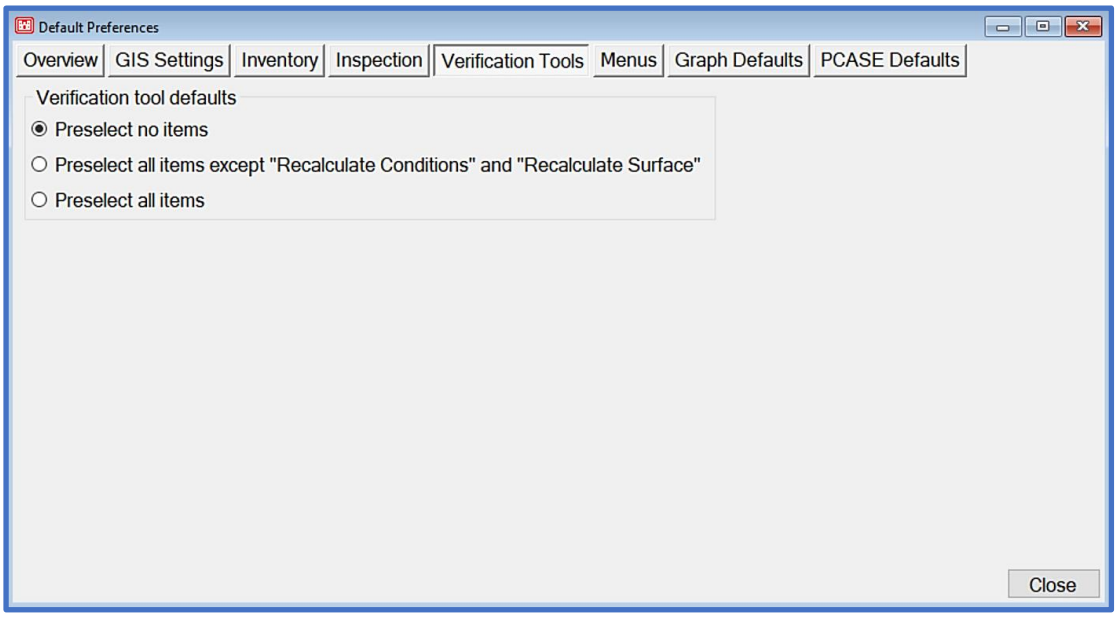
4.6.4 Inspection

The Inspection form options allow you to select how you would like PAVER™ Inspection form data to display for dates, distress entry, and quantity selection. This tab is only relevant if you have PAVER™ installed alongside PCASE 7.



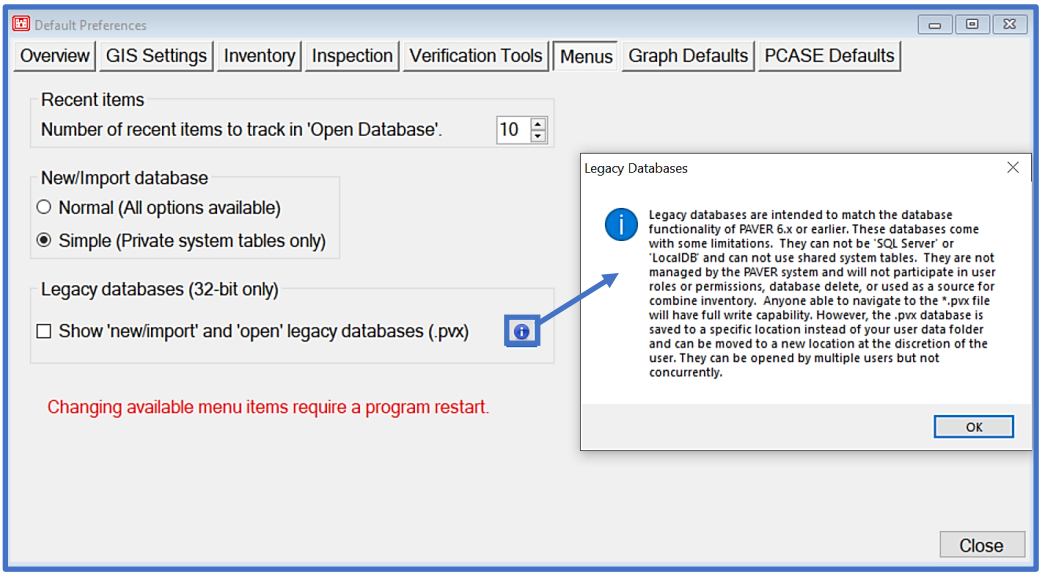
4.6.5 Verification Tools

The Verification Tools defaults pertain to PAVER™ Database Verification tools. These options are only relevant if you also have PAVER™ installed. When the Database Verification form opens some items are selected by default, you can use the Verification Tools tab to modify the default behavior for selection of items.



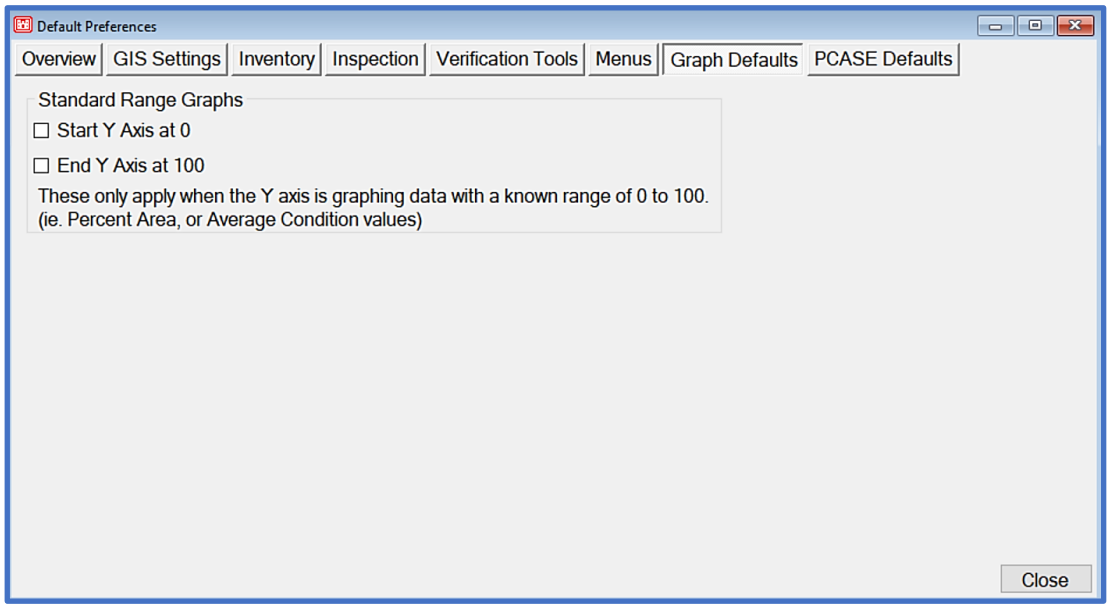
4.6.6 Menus

The Menus tab contains the two default database mode options; Normal or Simple modes. Simple mode is recommended for PCASE 7 users. Both of these options mainly impact how the database creation form is presented. The File menu options are also slightly different between the Normal and Simple modes. *Note: Changes made within this tab require a restart of PCASE 7 before they take effect.*



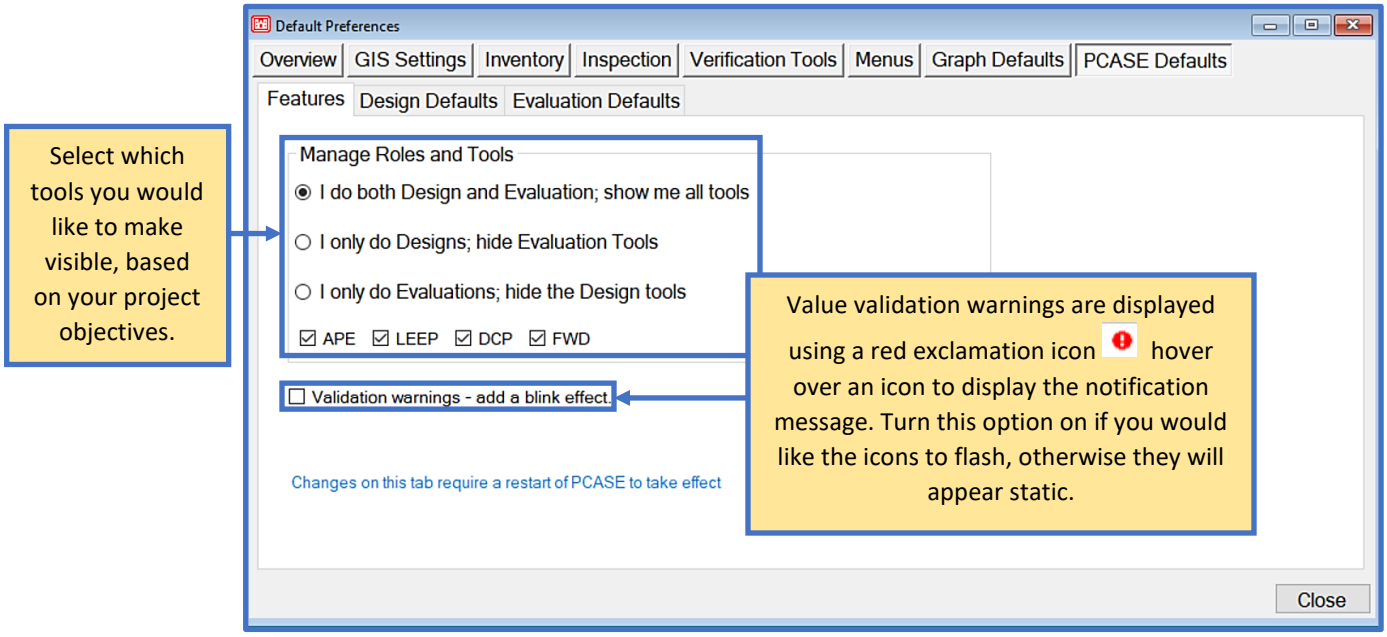
4.6.7 Graph Defaults

The Graph Defaults tab allows you to modify the Y-axis range for applicable graphs.

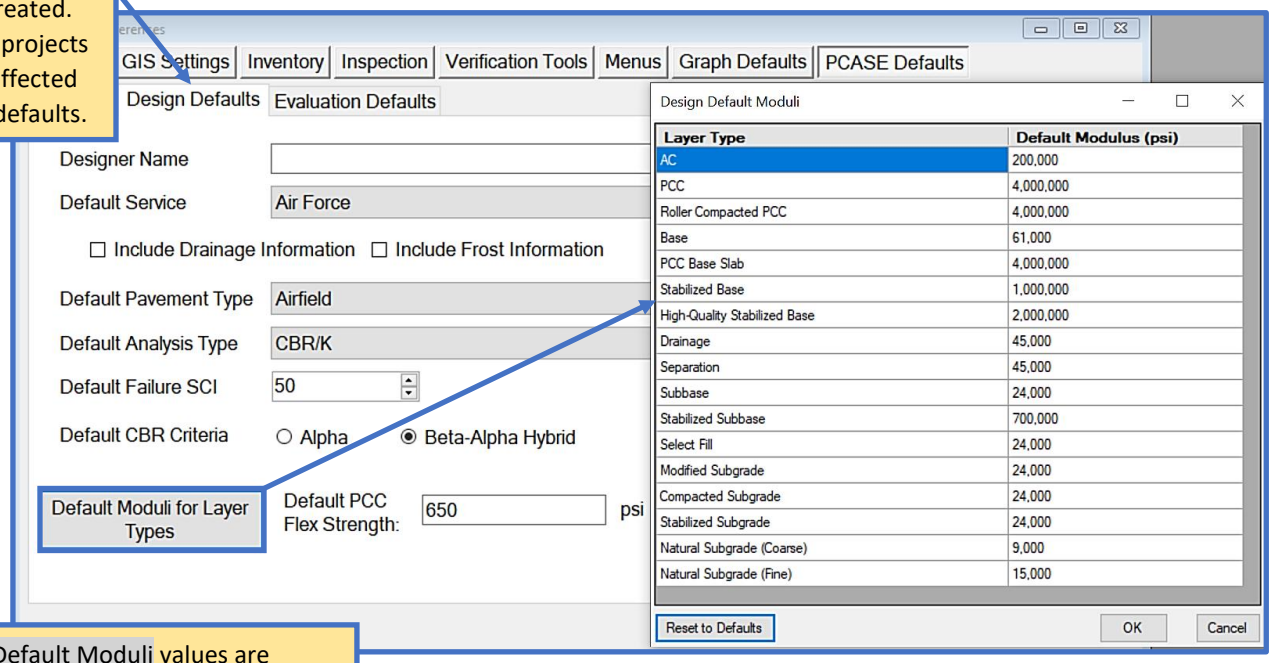


4.6.8 PCASE Defaults

The PCASE Defaults tab consists of three additional sub-tabs. The Features tab allows you to control visibility of Design and/or Evaluation tools, and the Design Defaults and Evaluation Defaults tabs contain module-specific default options. *Note: Changes made within this tab, require a restart of PCASE 7 to take effect.*

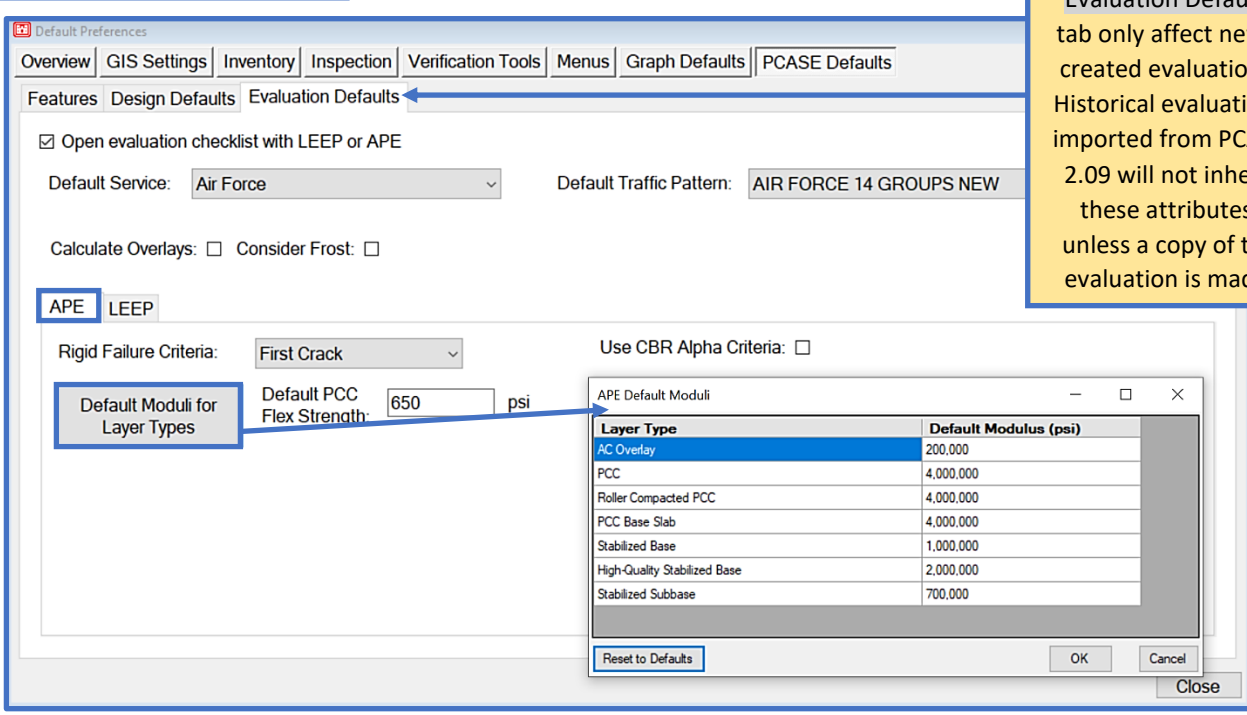


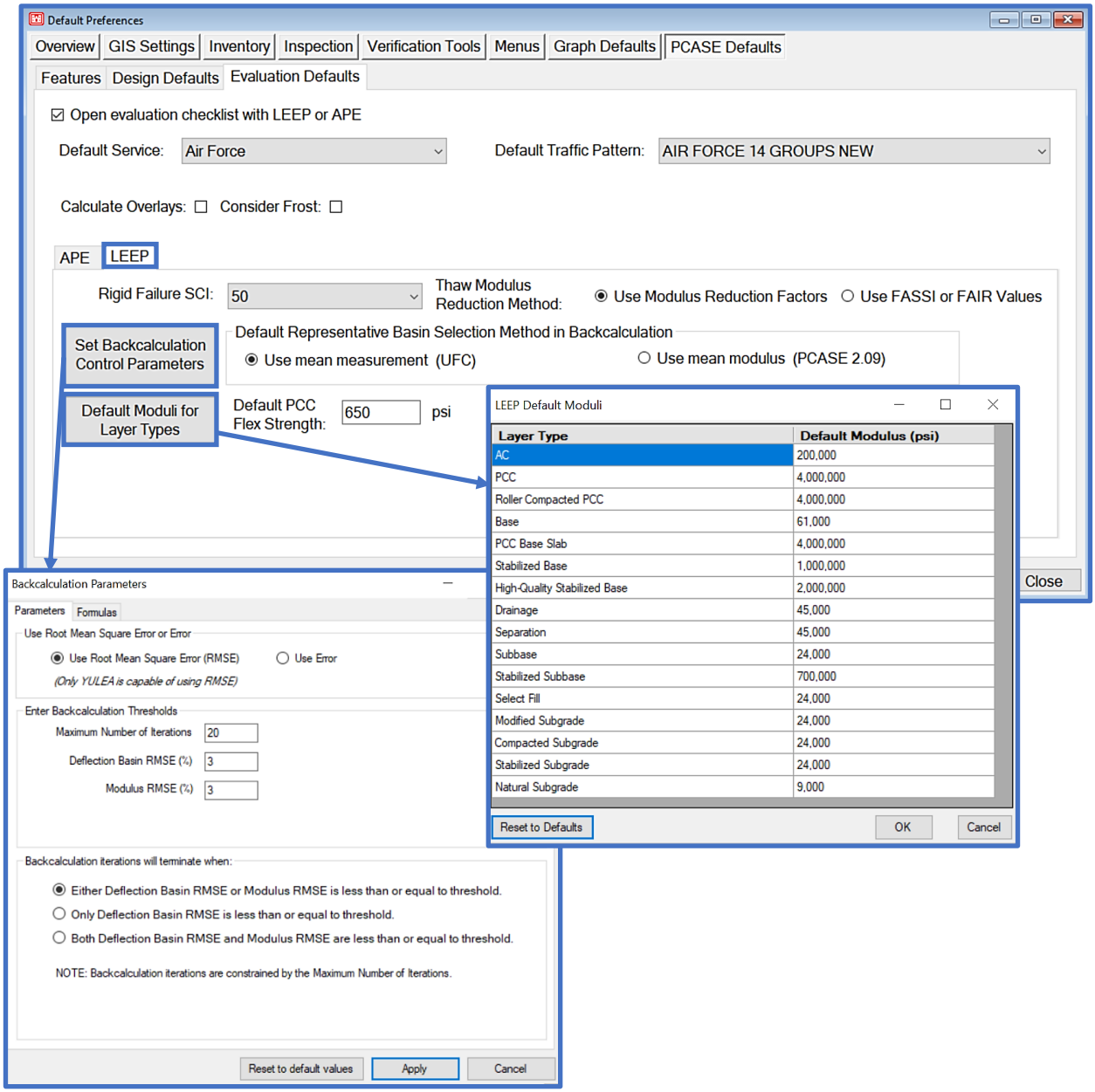
Design Defaults only apply to each new design project that is created. Historical projects are not affected by these defaults.



Default Moduli values are predetermined for each respective module. However, the default values can be overridden in both tabs.

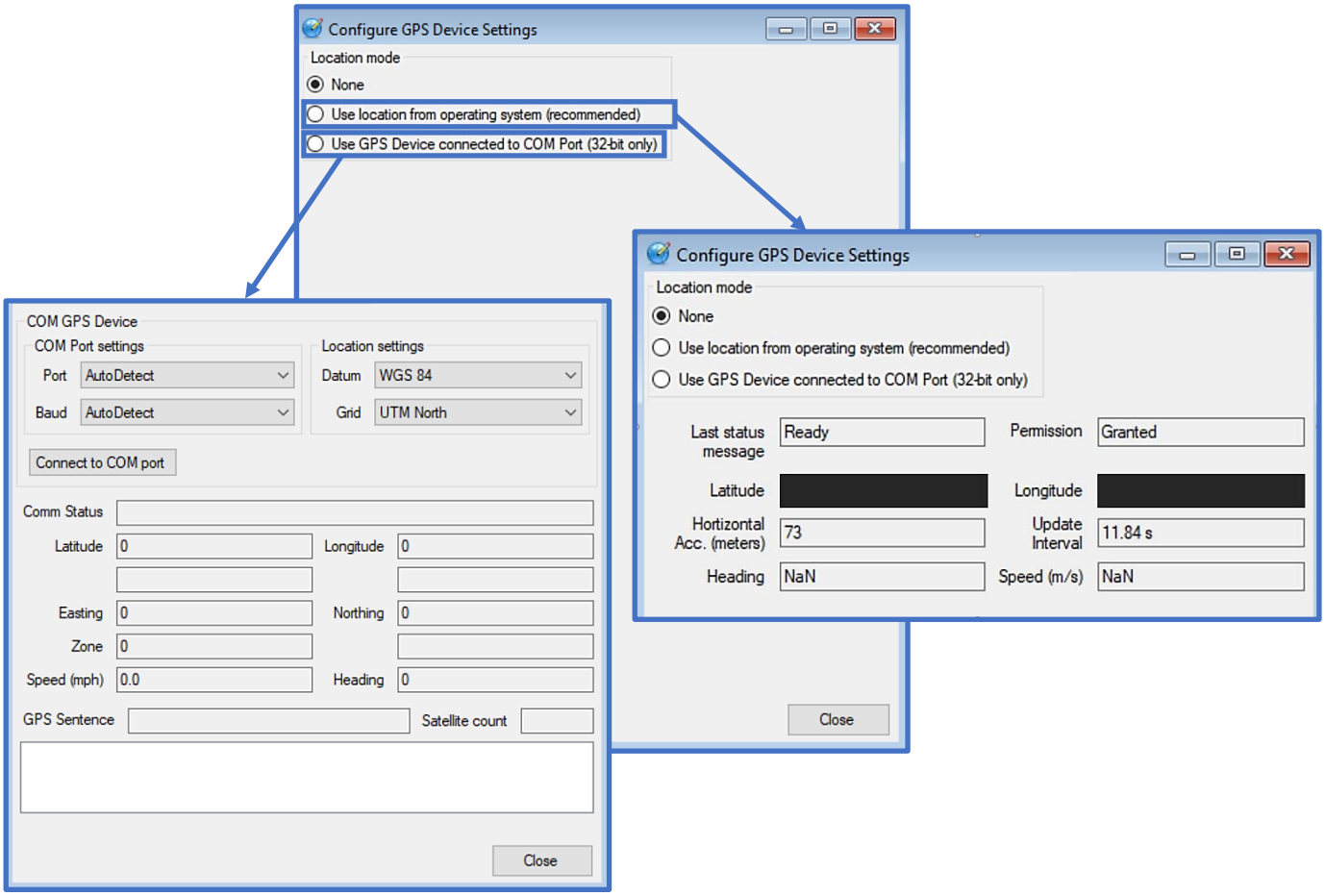
Changes made in the Evaluation Defaults tab only affect newly created evaluations. Historical evaluations imported from PCASE 2.09 will not inherit these attributes, unless a copy of the evaluation is made.




Default Preferences
Overview
GIS Settings
Inventory
Inspection
Verification Tools
Menus
Graph Defaults
PCASE Defaults
Features
Design Defaults
Evaluation Defaults
Open evaluation checklist with LEEP or APE
Default Service:
Air Force
Default Traffic Pattern:
AIR FORCE 14 GROUPS NEW
Calculate Overlays:
Consider Frost:
APE
LEEP
Rigid Failure SCI:
50
Thaw Modulus Reduction Method:
Use Modulus Reduction Factors
Use FASSI or FAIR Values
Set Backcalculation Control Parameters
Default Representative Basin Selection Method in Backcalculation
Use mean measurement (UFC)
Use mean modulus (PCASE 2.09)
Default Moduli for Layer Types
Default PCC Flex Strength:
650
psi
Close
LEEP Default Moduli
Layer Type
Default Modulus (psi)
AC 200,000
PCC 4,000,000
Roller Compacted PCC 4,000,000
Base 61,000
PCC Base Slab 4,000,000
Stabilized Base 1,000,000
High-Quality Stabilized Base 2,000,000
Drainage 45,000
Separation 45,000
Subbase 24,000
Stabilized Subbase 700,000
Select Fill 24,000
Modified Subgrade 24,000
Compacted Subgrade 24,000
Stabilized Subgrade 24,000
Natural Subgrade 9,000
Reset to Defaults
OK
Cancel
Backcalculation Parameters
Parameters
Formulas
Use Root Mean Square Error or Error
Use Root Mean Square Error (RMSE)
Use Error
(Only YULEA is capable of using RMSE)
Enter Backcalculation Thresholds
Maximum Number of Iterations
20
Deflection Basin RMSE (%)
3
Modulus RMSE (%)
3
Backcalculation iterations will terminate when:
Either Deflection Basin RMSE or Modulus RMSE is less than or equal to threshold.
Only Deflection Basin RMSE is less than or equal to threshold.
Both Deflection Basin RMSE and Modulus RMSE are less than or equal to threshold.
NOTE: Backcalculation iterations are constrained by the Maximum Number of Iterations.
Reset to default values
Apply
Cancel

4.7 GPS Device

The GPS Device settings allow you to turn GPS on and off and configure how your GPS location is derived. The None radio button option is the default Location mode setting, meaning GPS is turned off by default. Selecting one of the other options will reveal your GPS status, according the selected mode.

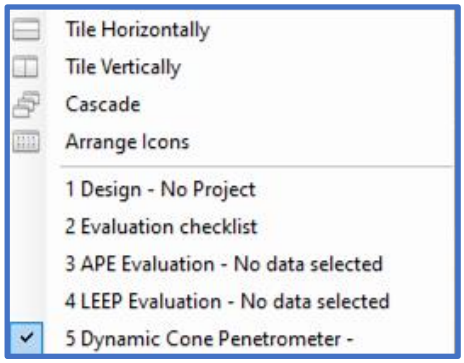


- Use location from operating system (recommended): In this mode, the Operating System attempts to coordinate between location providers to give the most accurate position. If the correct drivers are installed for your GPS device, this is the best mode to use. No configuration is required. This option works in both 32-bit and 64-bit modes. Windows will ask for permission to use your location information, if it doesn't already have permission. Permission must be granted in order for your location to be reported. When this option is enabled a horizontal accuracy (Horizontal Acc. (meters)) reading populates, if the number in this field is ≥ 75 meters then your GPS device probably isn't reporting location yet. After the GPS device locks on to satellites and starts reporting location, the accuracy radius will decrease; giving you a more accurate lock on your position. OS-level configuration of this setting can be found by searching for "Location privacy settings" in the control panel.

- Use GPS Device connected to COM port: This mode should only be used if your GPS device does not communicate with the OS. *Note: This option can only be used in 32-bit mode. Additionally, you may have to enter the Port and Baud rate manually in the Com Port settings.*

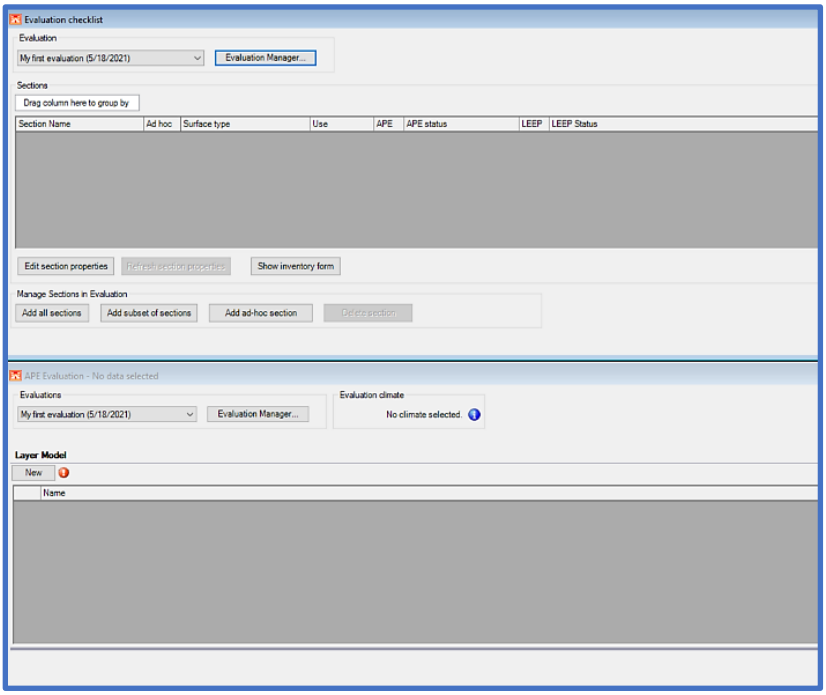
5 Window

The options within the Window menu allow you to adjust the manner in which each form is positioned in conjunction with other open forms. After you've selected one of these options, the lower portion of the menu will display an enumerated list of the forms that are currently open.



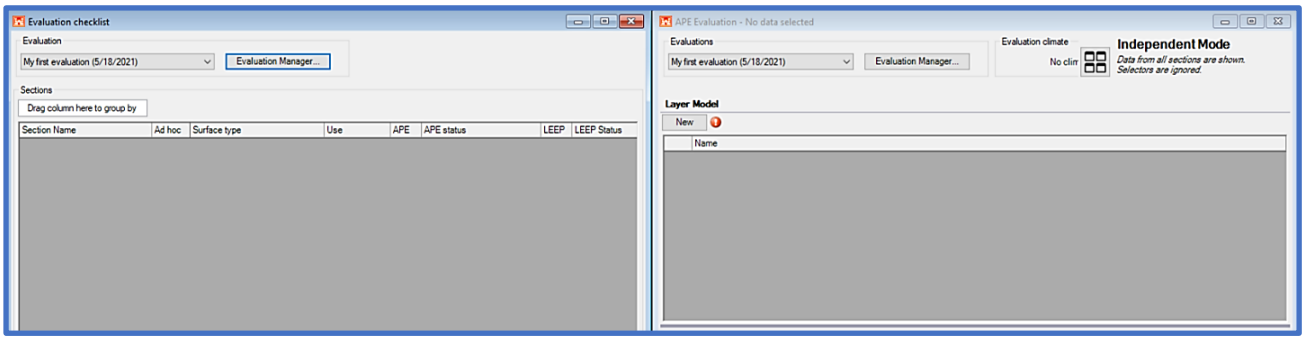
5.1 Tile Horizontally

If you opt to Tile Horizontally, any open form windows will become stacked in a horizontal manner.



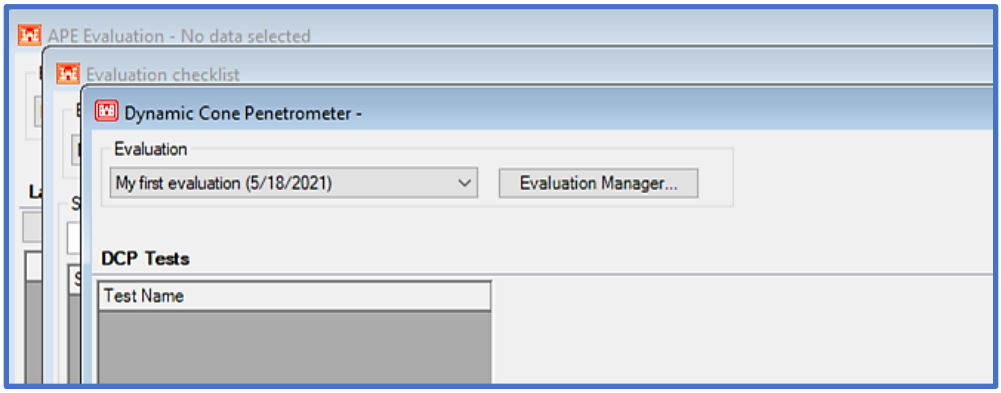
5.2 Tile Vertically

Tile Vertically works in the same manner as the Tile Horizontally option does, except the form windows will be situated next to each other in a vertical direction.



5.3 Cascade

Selecting the Cascade option will make any open forms display slightly staggered over each preceding form.



5.4 Arrange Icons

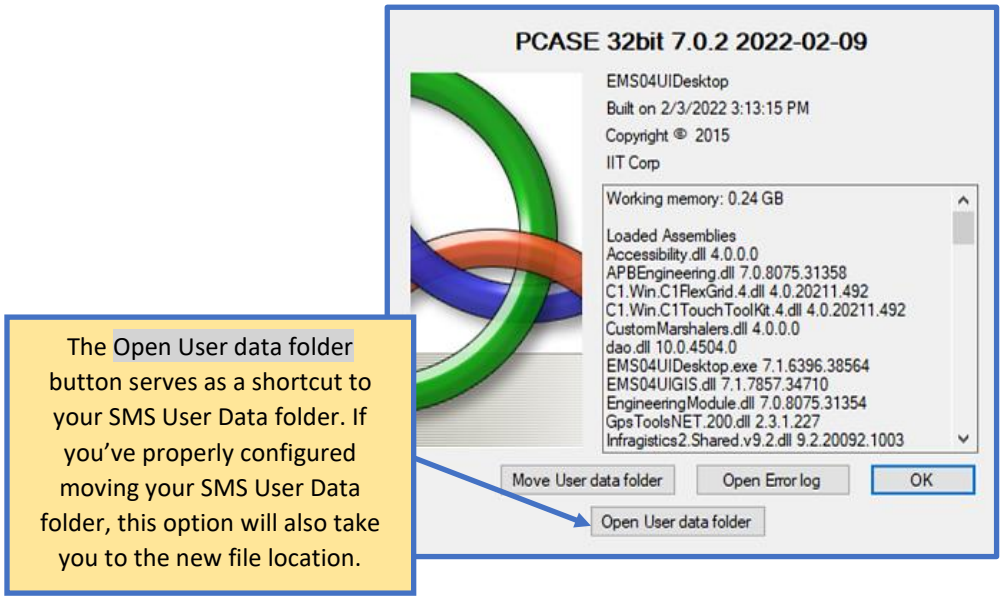
When open forms are minimized, the Arrange Icons option allows you to move around the minimized window icons at the bottom of the main PCASE 7 window.

6 Help

The Help menu consists of the following options: Program Version, Getting started with PCASE 7, and PCASE 7 User Guide. Program Version contains information about the PCASE 7 version currently installed, you can also access your user data folder or error log from this window. Getting started with PCASE 7 opens the pdf viewer that holds the library of help files for learning how to use the various modules within the program.

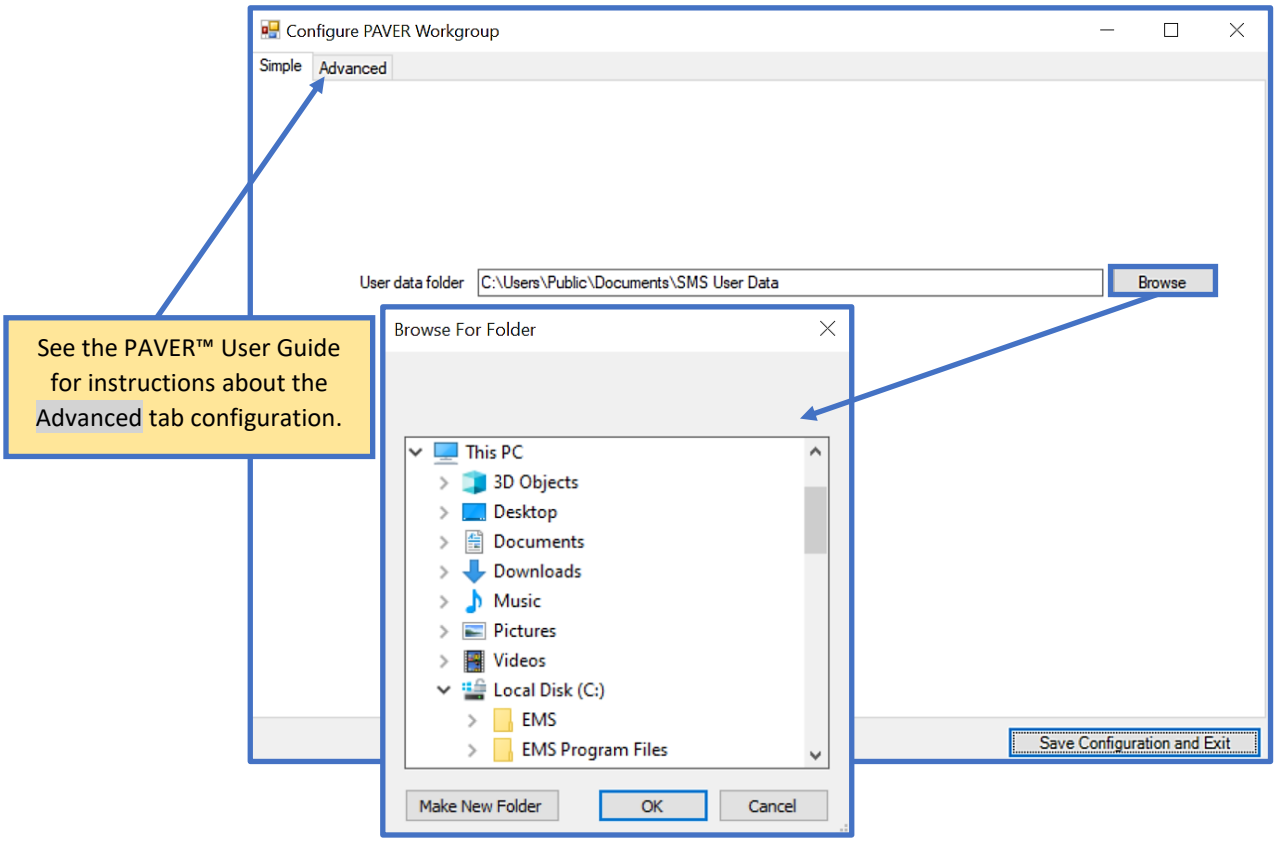
6.1 Program Version

The Program Version window contains information about the program build date and development information. You can also manage your user data folder and access your error log from this window.



6.1.1 Move User Data Folder

When PCASE 7 is installed on a computer for the first time, the SMS User Data folder is installed at the following default location: C:\Users\Public\Public Documents\SMS User Data. If you wish to move your SMS User Data folder to a different location, click on the Move User data folder button to begin the configuration process outside of PCASE 7. Once the Configure PAVER Workgroup window has opened, you can Browse to the location you would like to move your SMS User Data folder to. You can also choose to create a new folder by clicking on the Make New Folder button. After you've chosen a new destination, click on the Save Configuration and Exit button.



6.1.2 Open Error Log

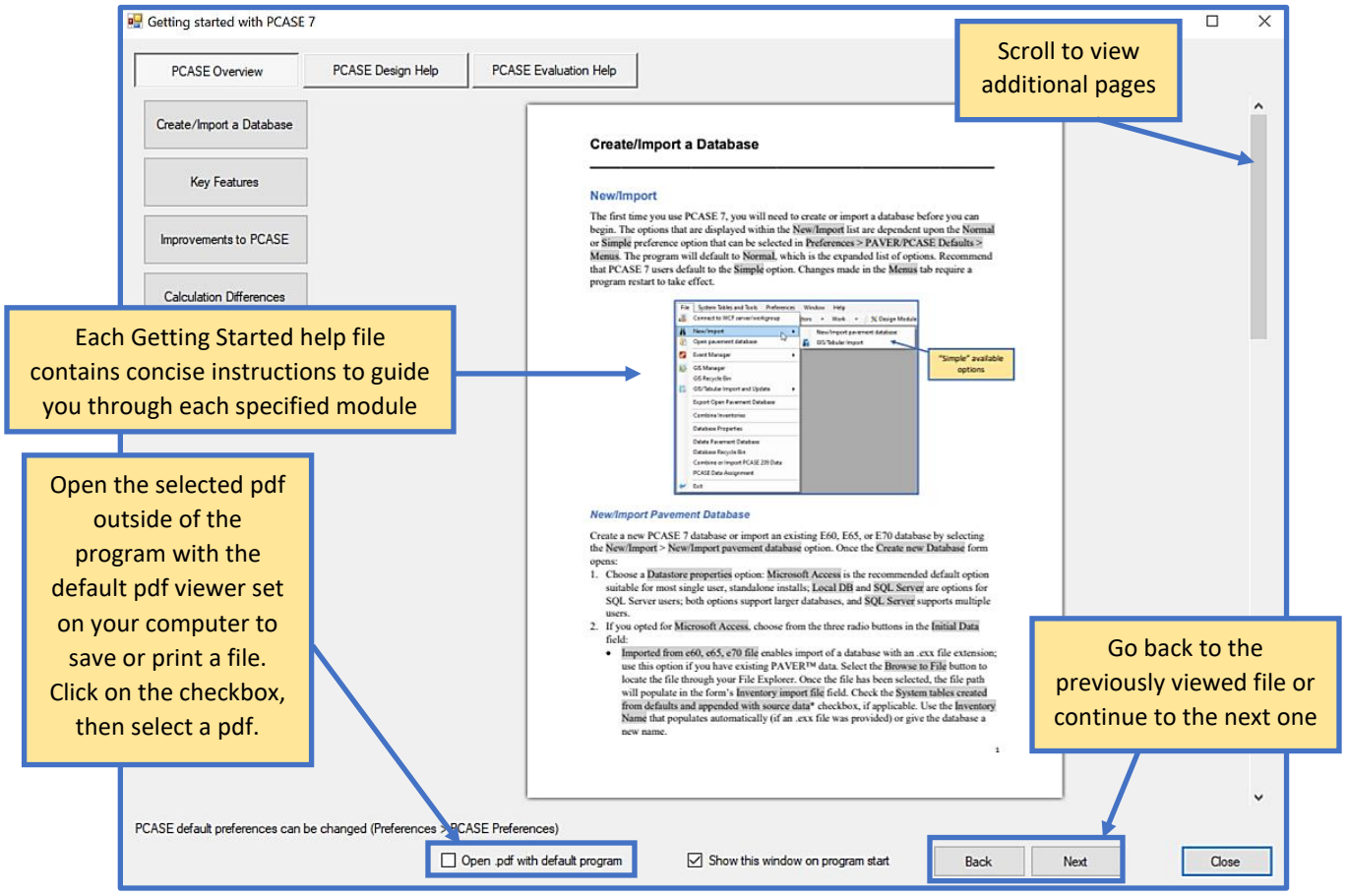
If an error message is displayed while using the program, the notification message will suggest that you open your Error Log and/or share it with the development team. Selecting the Open Error log button will open a Windows Notepad window which contains detailed information about any program errors that occurred. To view the most recent error(s), scroll to the bottom of the window. Sharing this information with the PCASE development team can help pinpoint and resolve any found issues.

```
----------
----------
Timestamp: 5/20/2021 12:43:10 PM
Message: Exception caught: ###  BUILD DATE 4/27/2021 5:33:17 PM   DLL VERSION 7.0.7810.22609 32-bit ###
Leep layerset
Exception.message: Object reference not set to an instance of an object.
 @pc07UIevaluationITL.LEEPLayersGrid.OnCellValueChanged(Object sender, DataGridViewCellEventArgs e) in \pc07UIevaluationITL\BindingHelpersLEEPGrids.c
 @ SMS04AddIn.UI.DataGridViewHelper`2.mDataGridView_CellValueChanged(Object sender, DataGridViewCellEventArgs e) in \SMS04AddInUI\BindingBase.vb:line

Category: Error

----------
----------
Timestamp: 5/20/2021 12:59:46 PM
Message: ###  BUILD DATE 4/27/2021 5:33:17 PM   DLL VERSION 7.0.7810.22609 32-bit ###
C:\Program Files\EMS\PCASE\resources
Category: Error

----------
```

6.2 Getting Started with PCASE 7

The Getting Started with PCASE 7 pdf viewer contains a library of help files for quick reference to help you get started using the program; more detailed information and examples for each module can be found in the PCASE 7 User Guide.

The PCASE Overview tab includes files intended to help you become acclimated with the program. The Create/Import a Database file is positioned first because creating or importing a database is a fundamental first step before using PCASE 7. The Key Features document describes the various components used throughout the program. Improvements to PCASE highlights advancements made between PCASE versions (2.09-7) and Calculation Differences outlines known calculation differences between versions. The PCASE Design Help tab includes files to get you started using the Design Module and the Design Traffic form; which is accessible from the Design Module. The PCASE Evaluation Help tab includes files for each of the evaluation modules. Define Inventory provides instructions for creating an inventory to be used in the evaluation modules. The Evaluation Checklist can be used to manage section properties and also works as a selector in conjunction with the APE, LEEP, FWD, or DCP forms when they are set to Selector Mode. Traffic for Evaluations explains how to use the Traffic form that is accessible through APE and LEEP. The remaining help files provide module-specific guidance for APE, LEEP, DCP, and FWD Data.



6.3 PCASE 7 User Guide

Select PCASE 7 User Guide to open the user guide document directly from the program.

7 Inventory

The Inventory tools give you the ability to create and manage inventory data including pavement inventory, GIS data, and Asset management.

7.1 Define Inventory

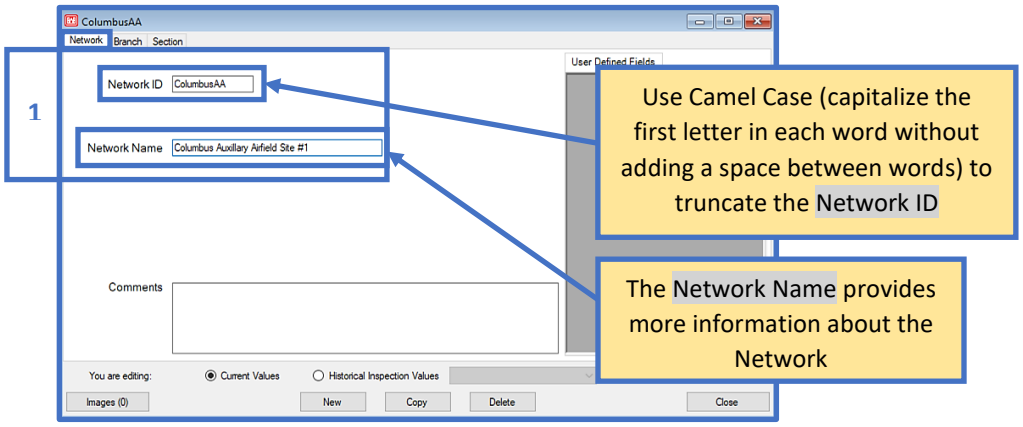
The Define Inventory form provides tools to view, edit, and define pavement inventory. Prior to beginning an evaluation, it is essential to divide the pavement system into manageable Sections. Sections are based on common characteristics including pavement type, thickness, use, traffic type, soil layers, pavement condition, and construction history. A pavement inventory is essentially comprised of all pavement types, grouped by their function. If the currently open database contains a defined inventory, you can view or edit inventory details within the Define Inventory form. The same form can be used to create an inventory from scratch, by first defining a Network, then Branches and Sections within that Network. *Note: The Define Inventory form defaults to opening to the Section tab first.*

7.1.1 Network

Click on the Network tab if you wish to view or create a pavement inventory Network. If a Network does not already exist, click on the New button at the bottom of the window and the form will populate with fields. Each inventory should contain at least one Network. An inventory may also have additional Networks for closed, housing, or privatized pavements. For multiple Networks within the same database; add characters at the end of truncated names to make the distinction clear.

1. Edit the Network ID and Network Name fields. Use the following recommended naming convention:

- Network ID: Based on site name (truncate to 10 characters).
- Network Name: Site Name (limited to 60 characters).



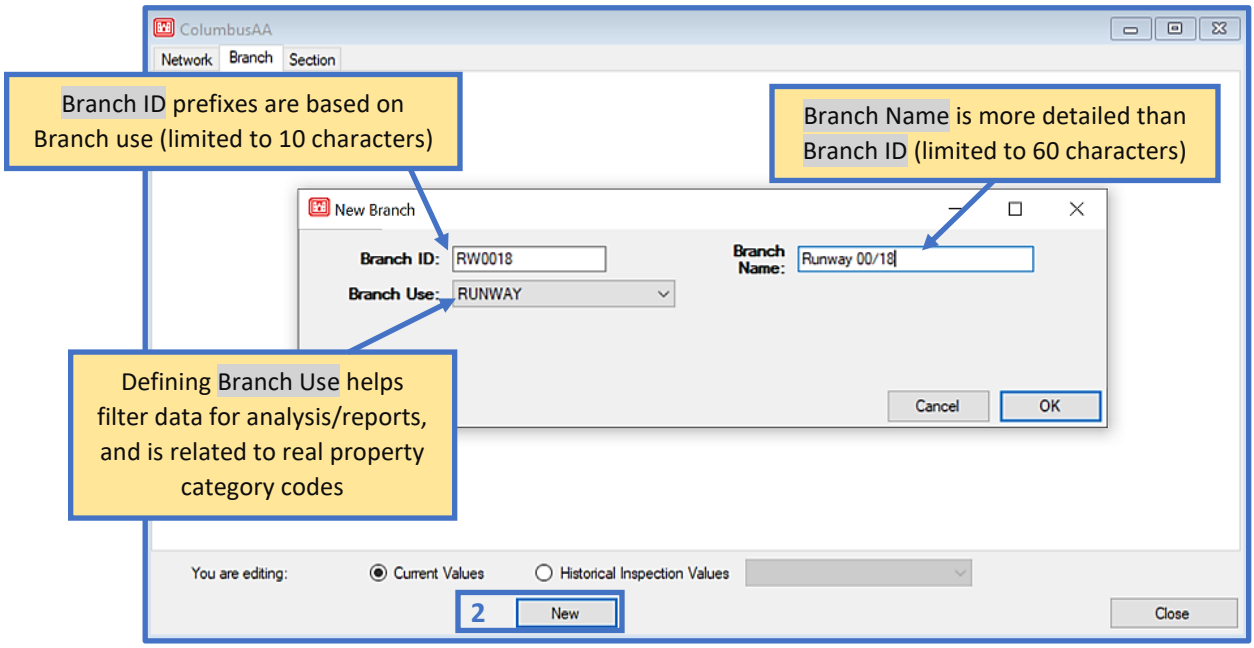
7.1.2 Branch

Branches are defined by pavement use. Examples of individual Branch segmentations are a runway, a named taxiway, a shoulder, a named road, or a contiguous parking area. See the tables below for further guidance on Branch identification.

Airfield Branch Identification	
Branch	**Branch ID Example**
RW = Runway	RW1028
TW = Taxiway	TWA
PA = Parking Apron	PAMain
AP = Other Apron	APMain
OA = Other Apron (AF)	OANWWARM
OR = Overrun	OR1028
HP = Helipad	HP1VTL
SH = Shoulder	SH1028

Road & Parking Branch Identification	
Branch	**Branch ID Example**
RD = Paved Road UR = Unpaved Road PA = Paved Parking Area UP = Unpaved Parking Area DW = Paved Driveway UD = Unpaved Driveway MP = Motor Pool SA = Staging Area or Parade Deck	The standard roadway Branch ID is the name of the road

2. To designate a Branch for a newly created Network select the Branch tab, then select New to populate fields for Branch ID, Branch Name, and Branch Use. Select OK once you've completed inputting Branch information. *Note: The same character restrictions that are enforced for Network ID and Network Name are also applied to Branch ID and Branch Name.*



7.1.3 Section

Each Branch is comprised of one or many Sections. Airfield Sections are defined by their physical characteristics and can be determined from imagery, UFC standards, pavement design, or construction records. Road and parking Sections must have the same pavement type and are assumed to be structurally similar; Sections are typically defined based on set intervals (eg., a break at an intersection). The tables below provide guidance for identifying airfield or road and parking Sections.

Airfield Section Identification		
R = Runway **T** = Taxiway **A** = Apron **H** = Helipad **O** = Overrun **S** = Shoulder	+ **Section number:** Pavement grouped by similar pavement type/thickness, base type/thickness/strength, subgrade type/Strength, etc. **Use: 01, 02, 03, …99**	+ **A** = Channelized traffic; full design weight **B** = Nonchannelized traffic; full design weight **C** = Nonchannelized traffic; traffic volume is low or 75% design weight **D** = Nonchannelized traffic; traffic volume is extremely low or 75% design weight, 1% of design passes
Example Section name: R01A		

Note: An airfield Section ID for a given installation is unique for that given installation.

Road & Parking Section Identification

Branch Identification				Section Identification	
RD = Paved Road **UR** = Unpaved Road **PA** = Paved Parking Area **UP** = Unpaved Parking Area	+	Street Name Road Function Parking Lot Function Building Number	+	**Segment Section by:** • Pavement Type • Pavement Rank • Change in Condition **Use:** 01, 02, 03, ...99	=

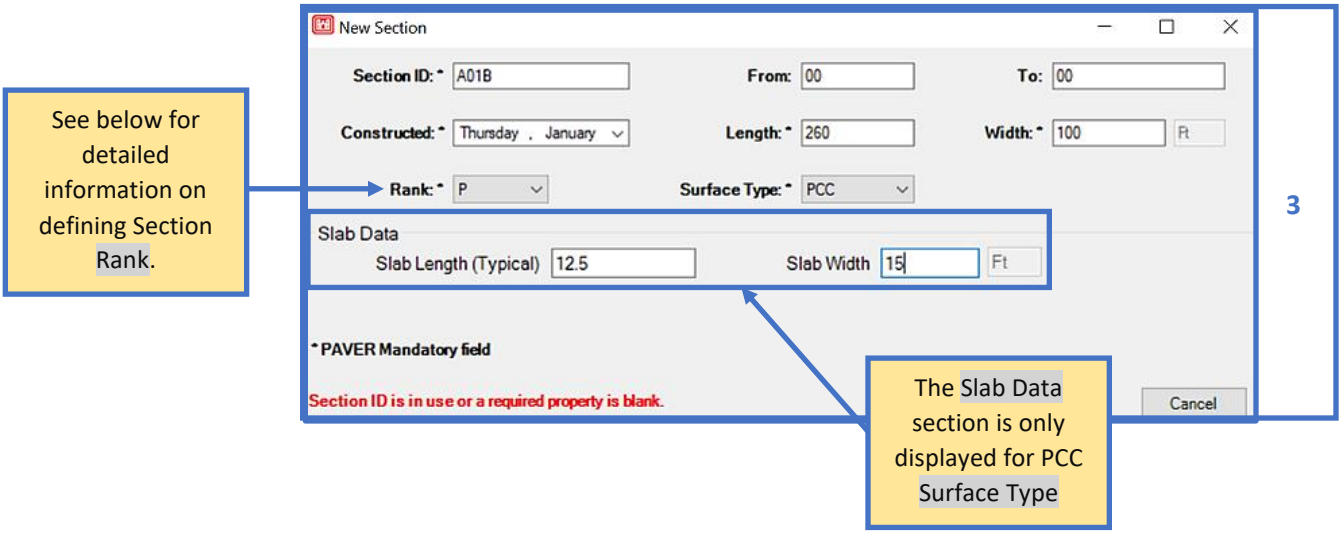
Example Section names:

RDFalcon 01

PA0300 01

URPerimeter 03

3. Select the Section tab, then the New button to begin adding Section data.



Airfield Section Rank		
Rank	**Code**	**Description**
Primary	P	Primary pavements are mission-essential pavements such as runways, parallel taxiways, main parking aprons, arm-disarm pads, alert aircraft pavements, and overruns (when used as a taxiway or for takeoff). In general, only pavements that have aircraft use on a daily basis or frequently used transient taxiways and parking areas are considered primary
Secondary	S	Secondary pavements are mission-essential but occasional-use airfield pavements, including ladder taxiways, infrequently used transient taxiway and parking areas, overflow parking areas, and overruns (when there is an aircraft arresting system present). In general, any pavements that do not have daily use by aircraft are secondary
Tertiary	T	Tertiary pavements include pavements used by towed or light aircraft, such as maintenance hangar access aprons, aero club parking, wash racks, and overruns (when not used as a taxiway or to test aircraft arresting gear). Paved shoulders are classified as tertiary. In general, any pavement that does not support aircraft taxiing under their own power or is used only intermittently is considered a tertiary pavement.
Unused	U	Unused pavements include any pavements that are abandoned (not maintained) or scheduled for demolition.
Road and Parking Section Rank		
Rank	**Code**	**Description**
Primary	P	Primary pavements include installation roads and streets that serve as the main distributing arteries (arterials) for traffic originating outside or within an installation. These pavements have high traffic volumes and speeds of 35 to 55 mph but may include collector or local streets that service mission critical facilities. Classification of vehicle parking areas as primary pavements should be restricted to those areas associated with access to mission-essential facilities, such as alert facilities, munitions facilities, and medical facilities.
Secondary	S	Secondary pavements include collector streets that gather and disperse traffic between arterials and local streets. They will have lower traffic volumes than primary pavements and speeds of 25 to 40 mph. Most parking areas that support daily traffic on a base are considered secondary pavements, unless a specific mission dictates otherwise.
Tertiary	T	Tertiary pavements include local streets that provide access from collector roads to individual facilities. Unsurfaced roads are also typically classified as tertiary. Any parking area that is not used on a daily basis or is excess to the standard facilities requirements is considered a tertiary pavement.
Unused	U	Unused pavements include any pavements that are abandoned (not maintained) or scheduled for demolition.

4. The Section tab contains additional fields for calculating area. The Calculated Area is a product of the Section's user-entered Length and Width and cannot be edited. Decreases in Section area (resulting from items like cutouts) should be entered as negative values. Calculated Area and Area Adjustment are totaled to obtain the True Area displayed (the value used in PCASE 7 calculations and reports). The True Area field can be edited directly if the true area of a Section is known, then PCASE 7 will calculate the Area Adjustment automatically. Area adjustments can also be made at the Branch-level.

   The formula for calculating Total Slabs is based on the sections True Area and the average Slab Length and Slab Width. See below.

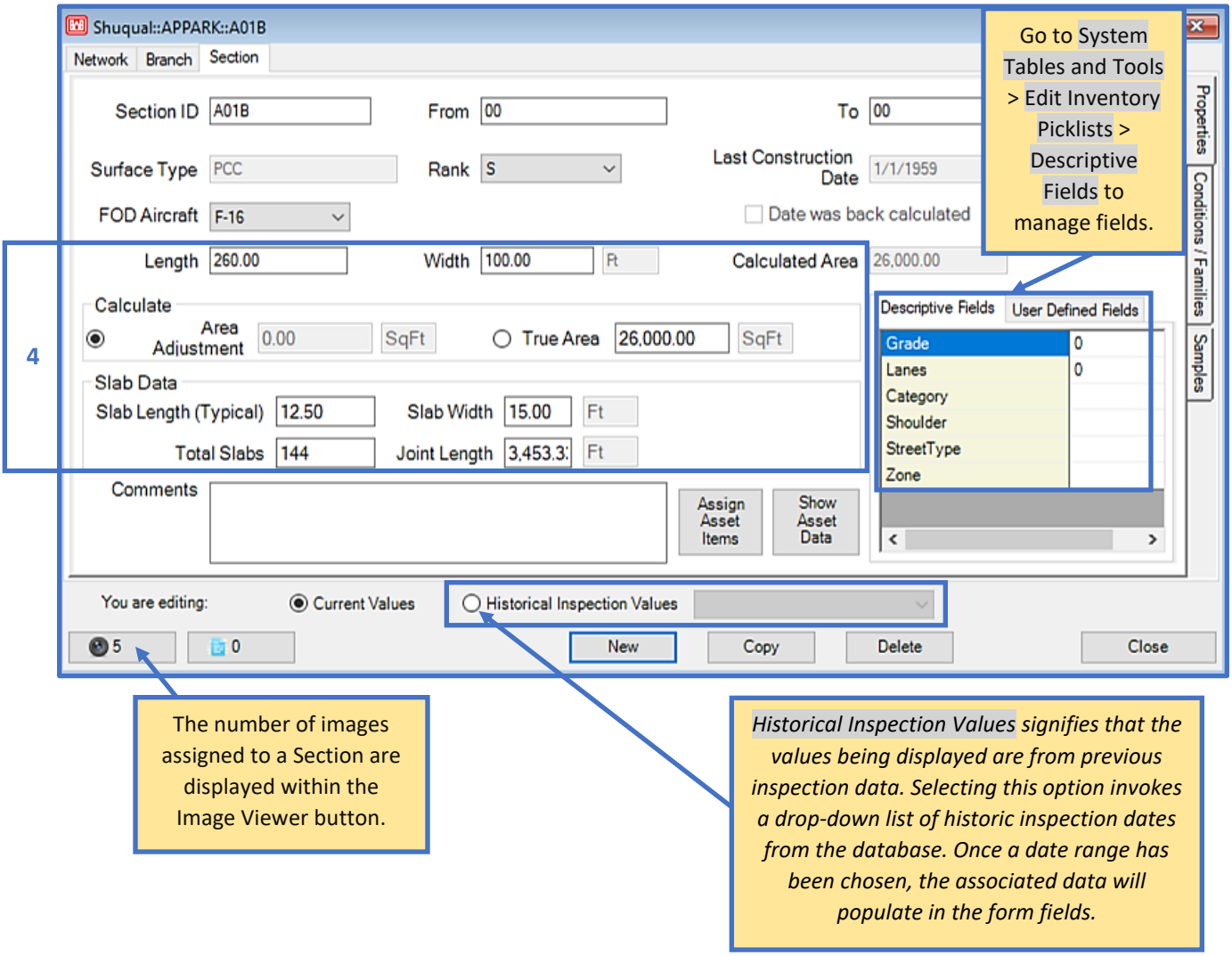
$$Total\ Slabs = \frac{True\ Area}{Slab\ Length\ \times Slab\ Width}$$

$$Total\ Slabs = \frac{11{,}200}{20\ \times 14} = 40\ Slabs$$

   The formula for calculating Joint Length is based on the average Slab Length and Slab Width, along with the dimensions of the Section. The formula used for Joint Length is shown below.

$$Joint\ Length = \left[\left(\frac{Section\ Length}{Slab\ Length}\right) - 1\right] \times Section\ Width + \left[\left(\frac{Section\ Width}{Slab\ Width}\right) - 1\right] \times Section\ Length$$

Note: Calculated values for Joint Length and/ or Total Slabs can be overridden.



Go to System Tables and Tools > Edit Inventory Picklists > Descriptive Fields to manage fields.

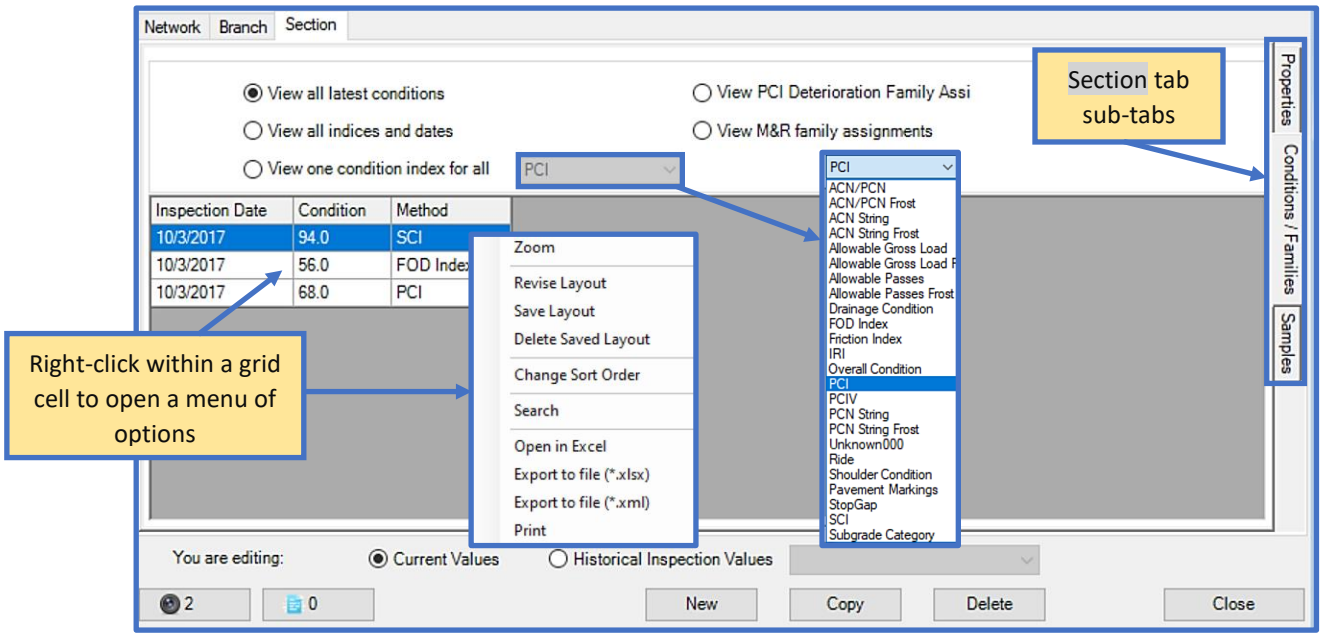
The number of images assigned to a Section are displayed within the Image Viewer button.

Historical Inspection Values signifies that the values being displayed are from previous inspection data. Selecting this option invokes a drop-down list of historic inspection dates from the database. Once a date range has been chosen, the associated data will populate in the form fields.

7.1.4 Condition/Families

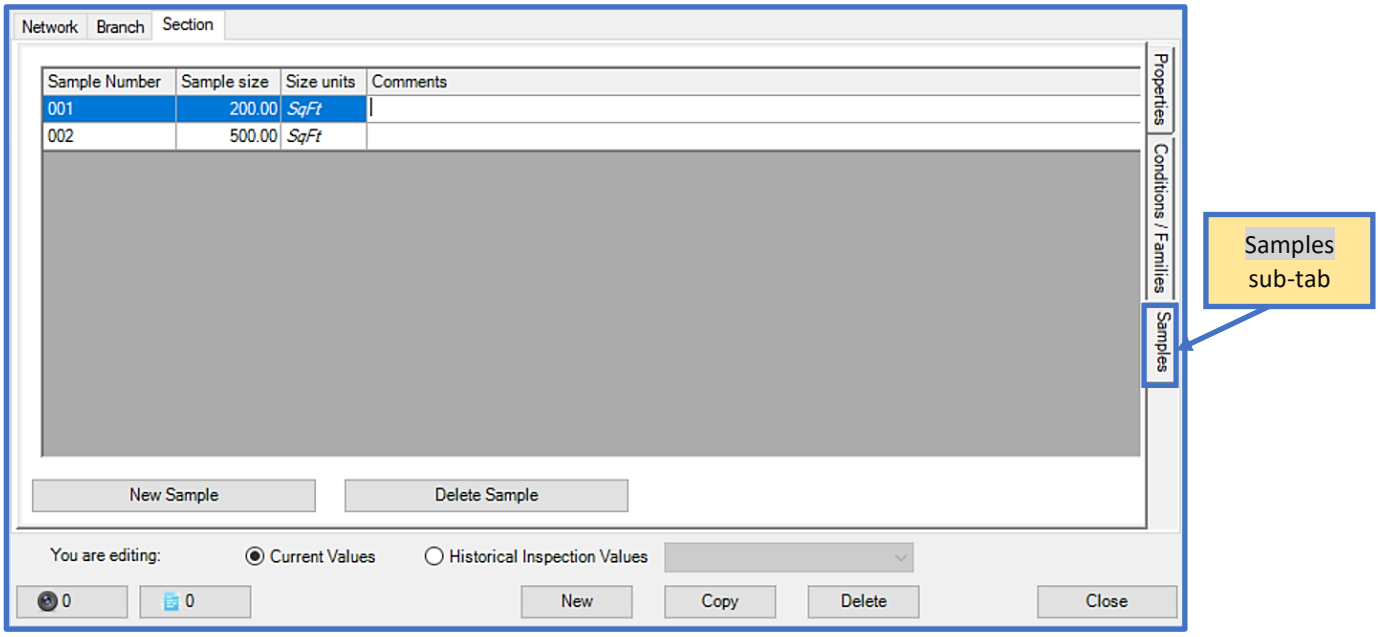
The Conditions/Families Section sub-tab offers a convenient way to view conditions associated with all construction and inspection dates and family assignment data.

- View all latest conditions: Displays a table with the last computed/inputted condition indices associated with the selected Section.
- View all indices and dates: A complete listing of every condition index for every date occurrence listed within the Section history.
- View one condition index for all dates: Shows all dates for each selected index. After selecting this option, the drop-list of condition indices will activate.
- View PCI Deterioration Family Assignments: Displays Family assignment data for the selected Section. You can also change the Family assignment with this option.
- View M & R family assignments: A table displays M &R Family types and Family names for the selected Section.



7.1.5 Samples

Samples can be added or deleted at the Section-level using the Samples sub-tab. Selecting New Sample creates a new row where you can edit the default Sample Number, Sample Size, and Comments fields. To delete a Sample, highlight the Sample row, then click on Delete Sample.



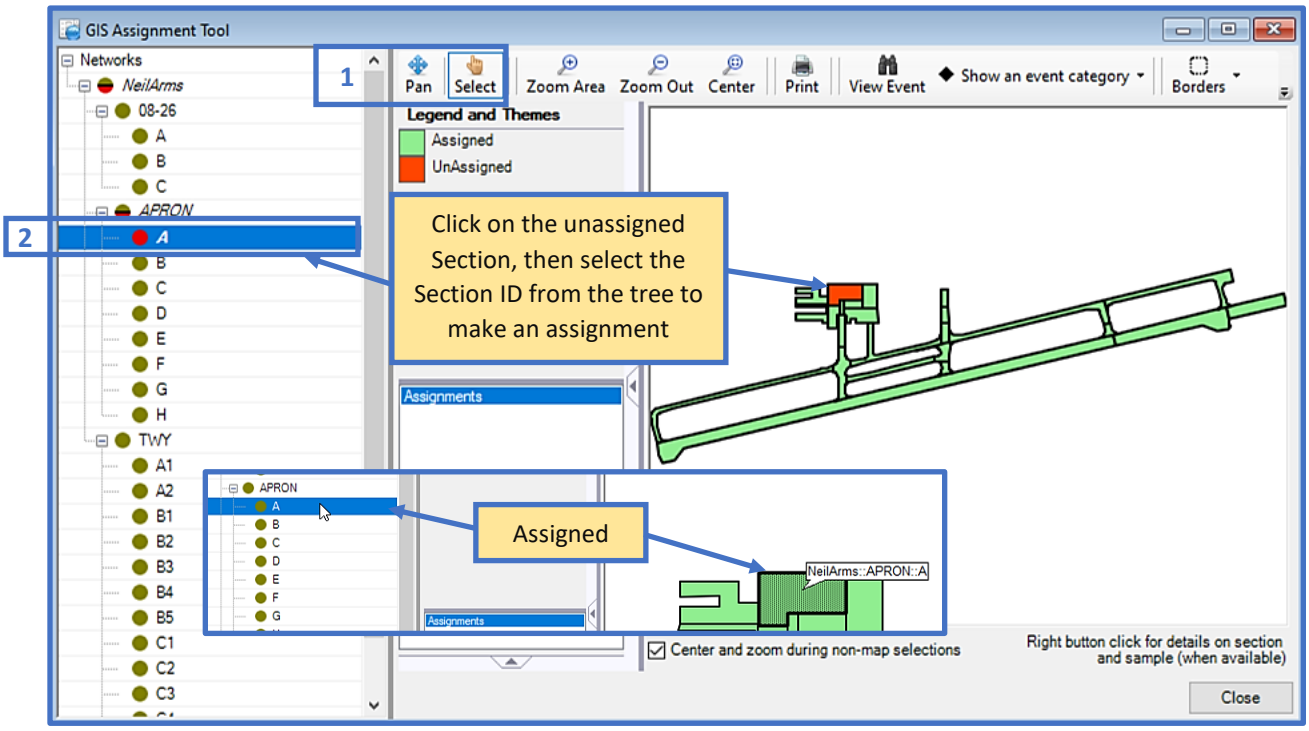
7.2 GIS Assignment

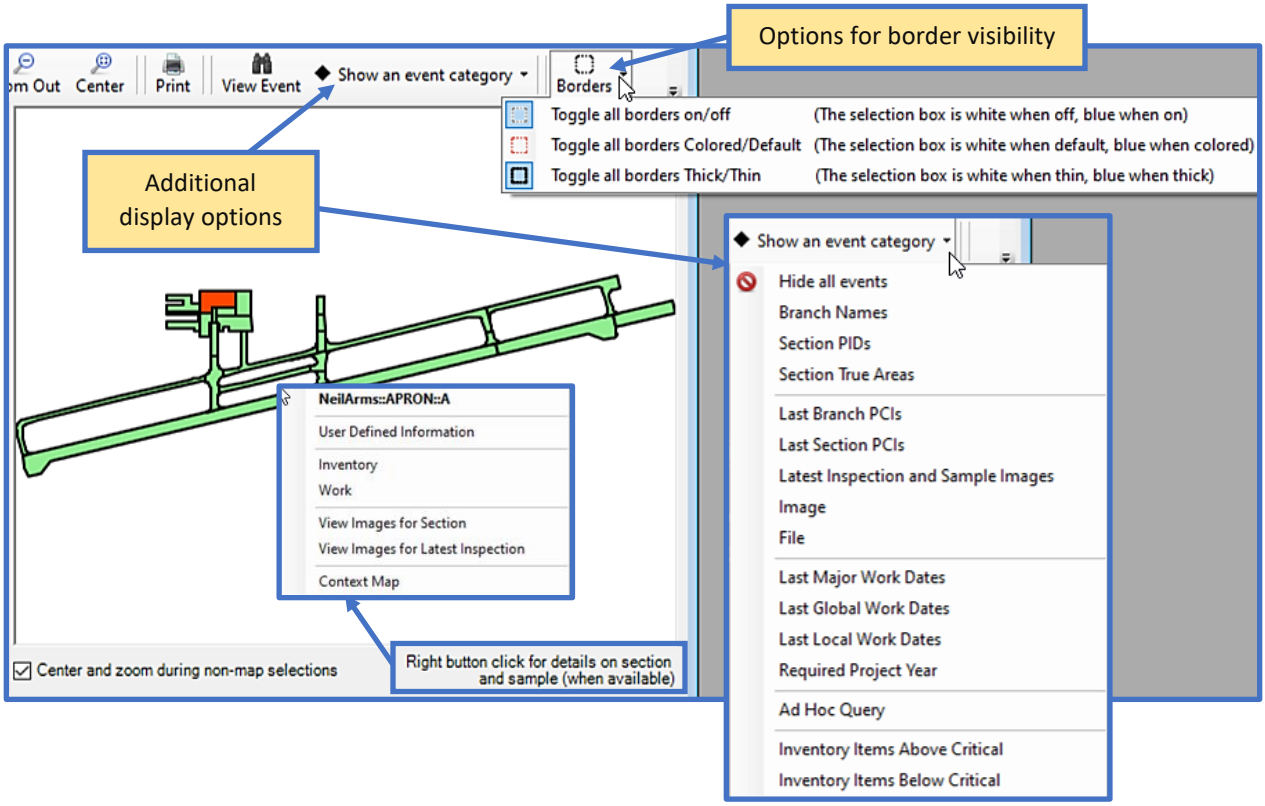
The GIS Assignment tool links Sections to GIS data, and allows you to create, remove, or modify the link between pavement inventory Sections and map features.

If GIS data has already been linked to Sections within the database; a tree selector list of the inventory and corresponding GIS map will populate. *Note: The GIS Assignment tool option will be disabled if the current database does not contain GIS data.*

1. The GIS Assignment Tool form opens in Select mode by default. If you wish to only view GIS data and not make Section assignment changes, switch to Pan mode.
2. Unassigned inventory Sections and GIS data will be colored red in the tree, and within the GIS map. To make an assignment, select an unassigned shape from the GIS map then select the Section ID in the tree. When the assignment has been completed, the Section ID and the map shape will be colored green.

To unassign a Section within the GIS map, double-click on the Section in the GIS map.

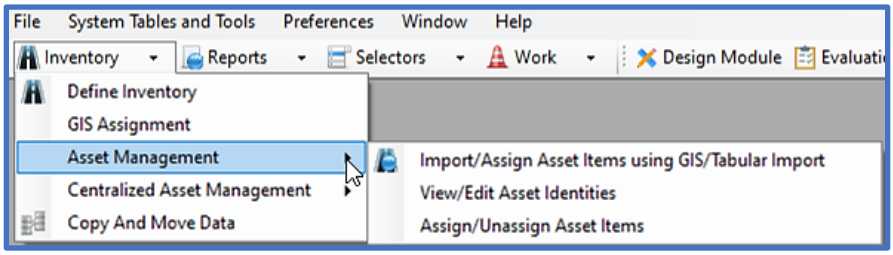

GIS Assignment Tool
Networks
NeilArms
08-26
A
B
C
APRON
A
B
C
D
E
F
G
H
TWY
A1
A2
B1
B2
B3
B4
B5
C1
C2
C3
1
2
Pan
Select
Zoom Area
Zoom Out
Center
Print
View Event
Show an event category
Borders
Legend and Themes
Assigned
UnAssigned
Click on the unassigned Section, then select the Section ID from the tree to make an assignment
Assignments
Assigned
NeilArms::APRON::A
Center and zoom during non-map selections
Right button click for details on section and sample (when available)
Close


Options for border visibility
Center
Print
View Event
Show an event category
Borders
Toggle all borders on/off (The selection box is white when off, blue when on)
Toggle all borders Colored/Default (The selection box is white when default, blue when colored)
Toggle all borders Thick/Thin (The selection box is white when thin, blue when thick)
Additional display options
Show an event category
Hide all events
Branch Names
Section PIDs
Section True Areas
Last Branch PCIs
Last Section PCIs
Latest Inspection and Sample Images
Image
File
Last Major Work Dates
Last Global Work Dates
Last Local Work Dates
Required Project Year
Ad Hoc Query
Inventory Items Above Critical
Inventory Items Below Critical
NeilArms::APRON::A
User Defined Information
Inventory
Work
View Images for Section
View Images for Latest Inspection
Context Map
Center and zoom during non-map selections
Right button click for details on section and sample (when available)

7.3 Asset Management

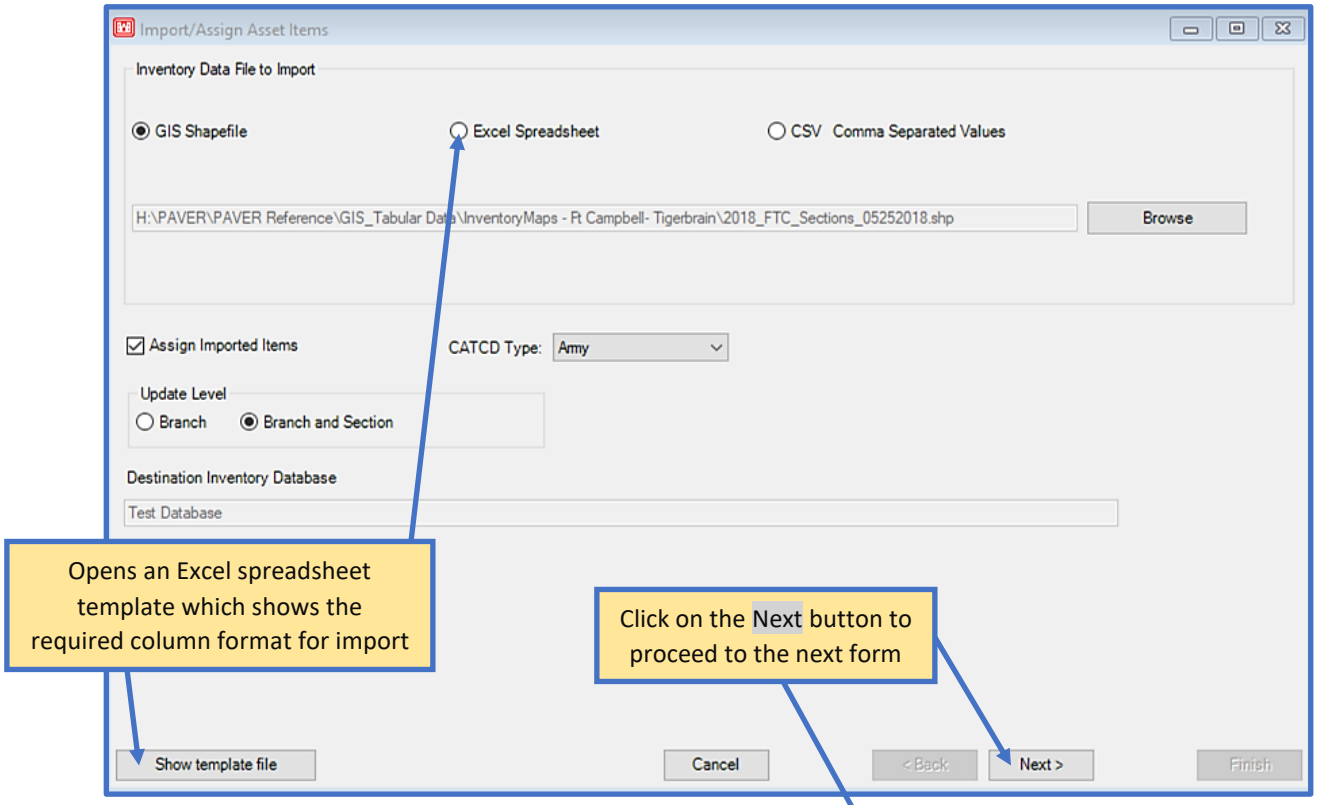
The Asset Management tools allow you to view an inventory through an Asset Management perspective. Assigning Assets to an inventory creates an association between the pavement inventory and the Real Property inventory. Additionally, once this link has been established, reporting tools can be ran using Asset parameters. Asset items can be imported into PCASE 7 using the Import/Assign Asset Items using GIS/Tabular Import tool; where you can view and/or edit Asset identities and make assignments.

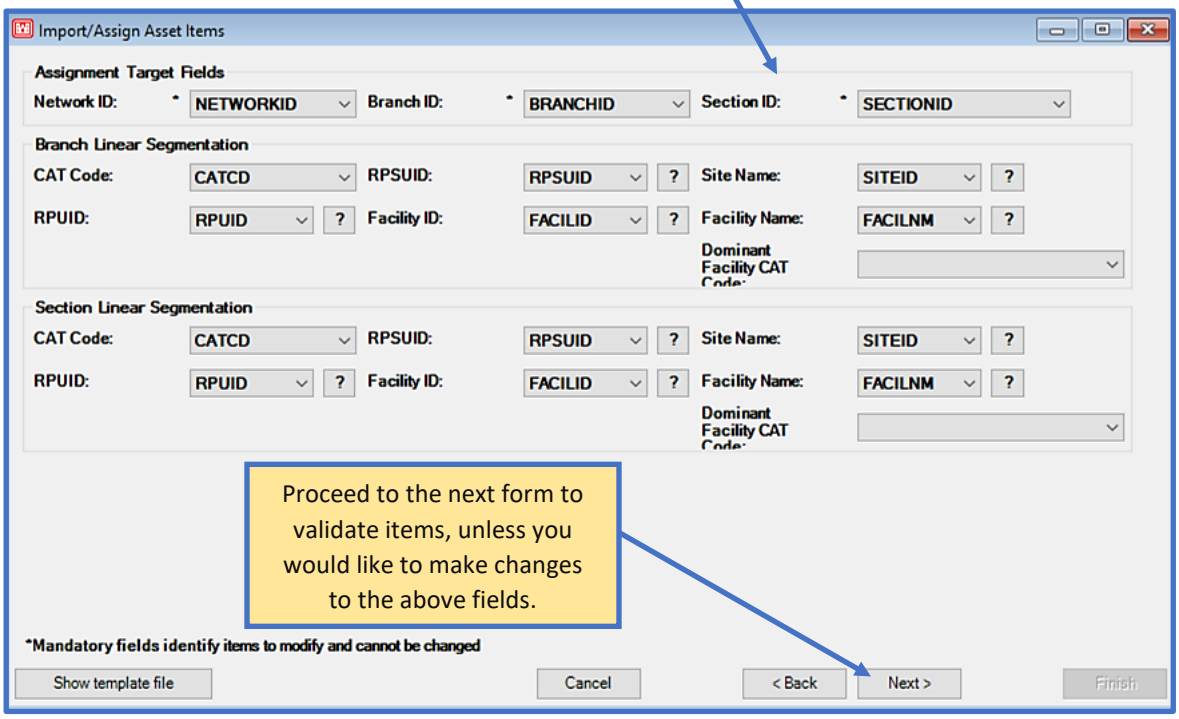
Note: In order to use these tools, turn on Show Asset Items under File > Database Properties > Preferences. Once Show Asset Items has been enabled, the tool options will appear beneath the GIS Assignment tool.



7.3.1 Import/Assign Asset Items using GIS/Tabular Import

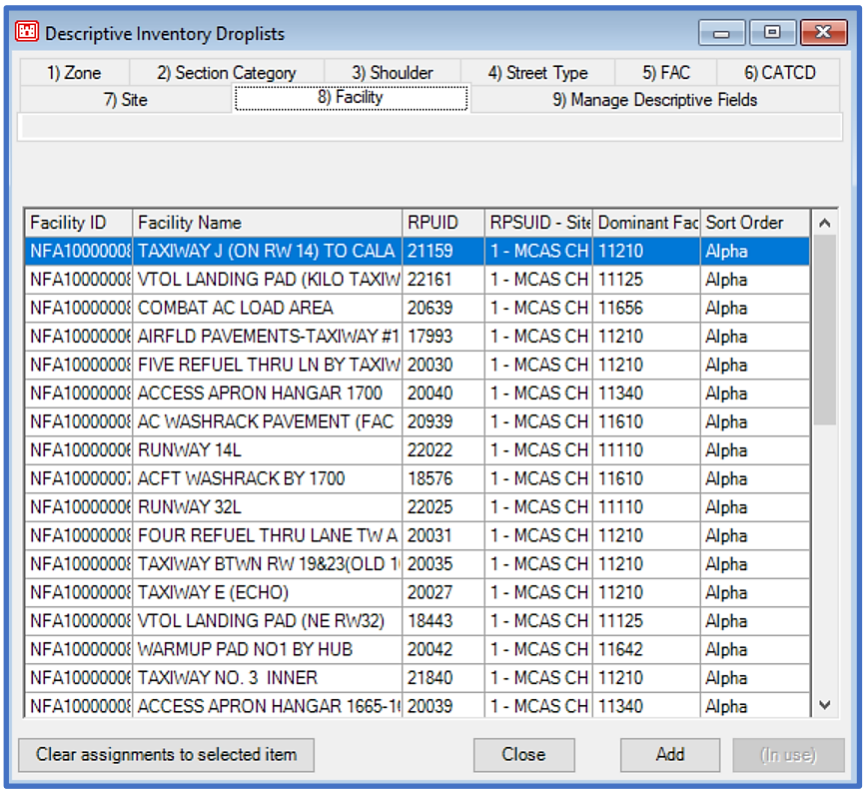
The Import/Assign Asset Items form is modelled after the GIS/Tabular Import form, and follows a similar workflow. First select a file type to import within the Inventory Data File to Import group, then Browse to the Asset data file location on your computer. Once you've selected a file, the file path will populate in the field next to the Browse button. Select the Assign Imported Items checkbox if you wish to assign the imported Asset data, and choose an Update Level option. After the required fields have been satisfied the Next button will enable so that you may continue to the next few steps. Options for assigning Asset items will follow once the import process has been completed. For more information on assigning Asset items, refer to Section 7.3.2.


Import/Assign Asset Items
Inventory Data File to Import
GIS Shapefile
Excel Spreadsheet
CSV Comma Separated Values
H:\PAVER\PAVER Reference\GIS_Tabular Data\InventoryMaps - Ft Campbell- Tigerbrain\2018_FTC_Sections_05252018.shp
Browse
Assign Imported Items
CATCD Type:
Army
Update Level
Branch
Branch and Section
Destination Inventory Database
Test Database
Opens an Excel spreadsheet template which shows the required column format for import
Click on the Next button to proceed to the next form
Show template file
Cancel
< Back
Next >
Finish


Import/Assign Asset Items
Assignment Target Fields
Network ID:
NETWORKID
Branch ID:
BRANCHID
Section ID:
SECTIONID
Branch Linear Segmentation
CAT Code:
CATCD
RPSUID:
RPSUID
Site Name:
SITEID
RPUID:
RPUID
Facility ID:
FACILID
Facility Name:
FACILNM
Dominant Facility CAT Code:
Section Linear Segmentation
CAT Code:
CATCD
RPSUID:
RPSUID
Site Name:
SITEID
RPUID:
RPUID
Facility ID:
FACILID
Facility Name:
FACILNM
Dominant Facility CAT Code:
Proceed to the next form to validate items, unless you would like to make changes to the above fields.
*Mandatory fields identify items to modify and cannot be changed
Show template file
Cancel
< Back
Next >
Finish

7.3.2 View/Edit Asset Identities

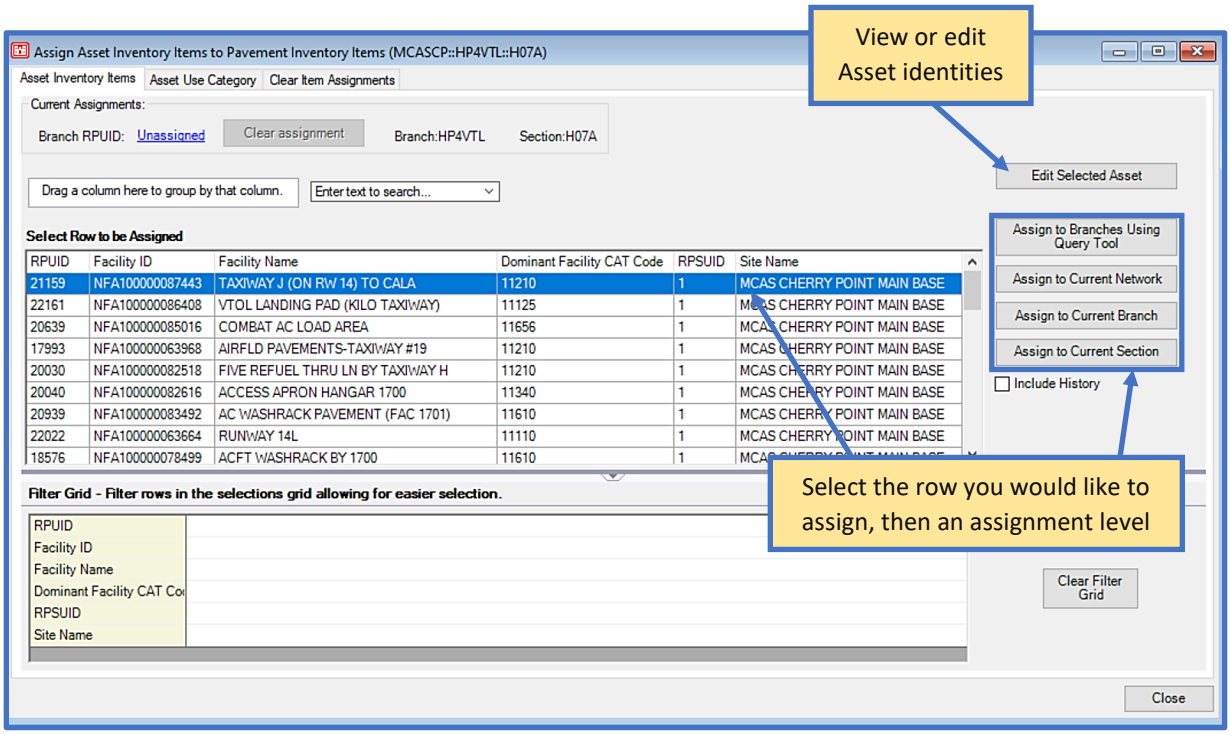
Assets can be created and edited individually in the system tables using the View/Edit Asset Identities tool. The Add button creates a new row within the tab you currently have open so that you can enter information directly in the grid. The Delete button will display when the selected row can be deleted – information that is currently in use within the database cannot be deleted. Assignments can also be undone by selecting a row, then the Clear assignments to selected item button.



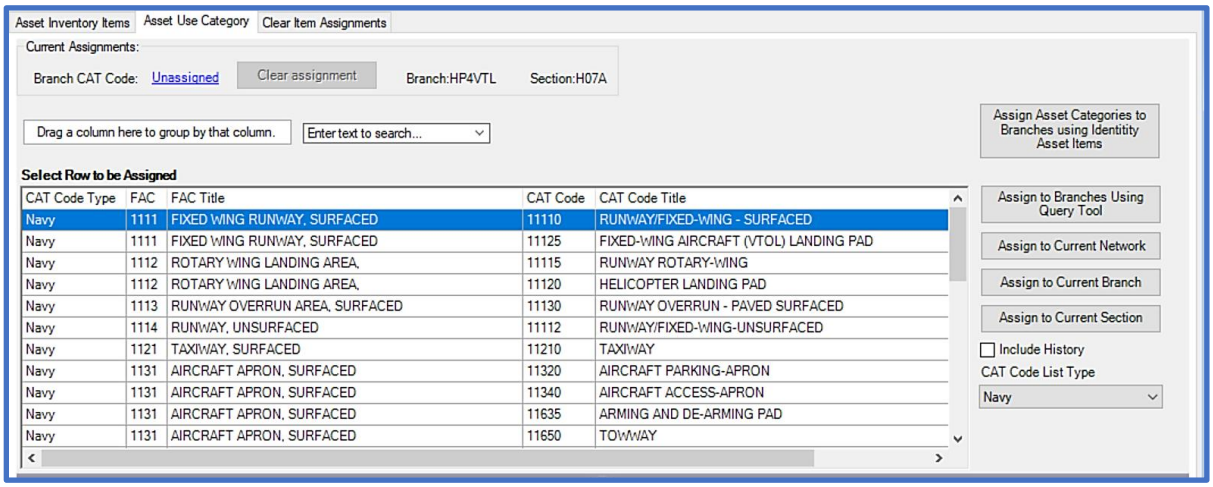
Facility ID	Facility Name	RPUID	RPSUID - Site	Dominant Fac	Sort Order
NFA10000008	TAXIWAY J (ON RW 14) TO CALA	21159	1 - MCAS CH	11210	Alpha
NFA10000008	VTOL LANDING PAD (KILO TAXIW	22161	1 - MCAS CH	11125	Alpha
NFA10000008	COMBAT AC LOAD AREA	20639	1 - MCAS CH	11656	Alpha
NFA10000006	AIRFLD PAVEMENTS-TAXIWAY #1	17993	1 - MCAS CH	11210	Alpha
NFA10000008	FIVE REFUEL THRU LN BY TAXIW	20030	1 - MCAS CH	11210	Alpha
NFA10000008	ACCESS APRON HANGAR 1700	20040	1 - MCAS CH	11340	Alpha
NFA10000008	AC WASHRACK PAVEMENT (FAC	20939	1 - MCAS CH	11610	Alpha
NFA10000006	RUNWAY 14L	22022	1 - MCAS CH	11110	Alpha
NFA10000007	ACFT WASHRACK BY 1700	18576	1 - MCAS CH	11610	Alpha
NFA10000006	RUNWAY 32L	22025	1 - MCAS CH	11110	Alpha
NFA10000008	FOUR REFUEL THRU LANE TW A	20031	1 - MCAS CH	11210	Alpha
NFA10000008	TAXIWAY BTWN RW 19&23(OLD 1	20035	1 - MCAS CH	11210	Alpha
NFA10000008	TAXIWAY E (ECHO)	20027	1 - MCAS CH	11210	Alpha
NFA10000008	VTOL LANDING PAD (NE RW32)	18443	1 - MCAS CH	11125	Alpha
NFA10000008	WARMUP PAD NO1 BY HUB	20042	1 - MCAS CH	11642	Alpha
NFA10000006	TAXIWAY NO. 3 INNER	21840	1 - MCAS CH	11210	Alpha
NFA10000008	ACCESS APRON HANGAR 1665-1	20039	1 - MCAS CH	11340	Alpha

7.3.3 Assign/Unassign Asset Items

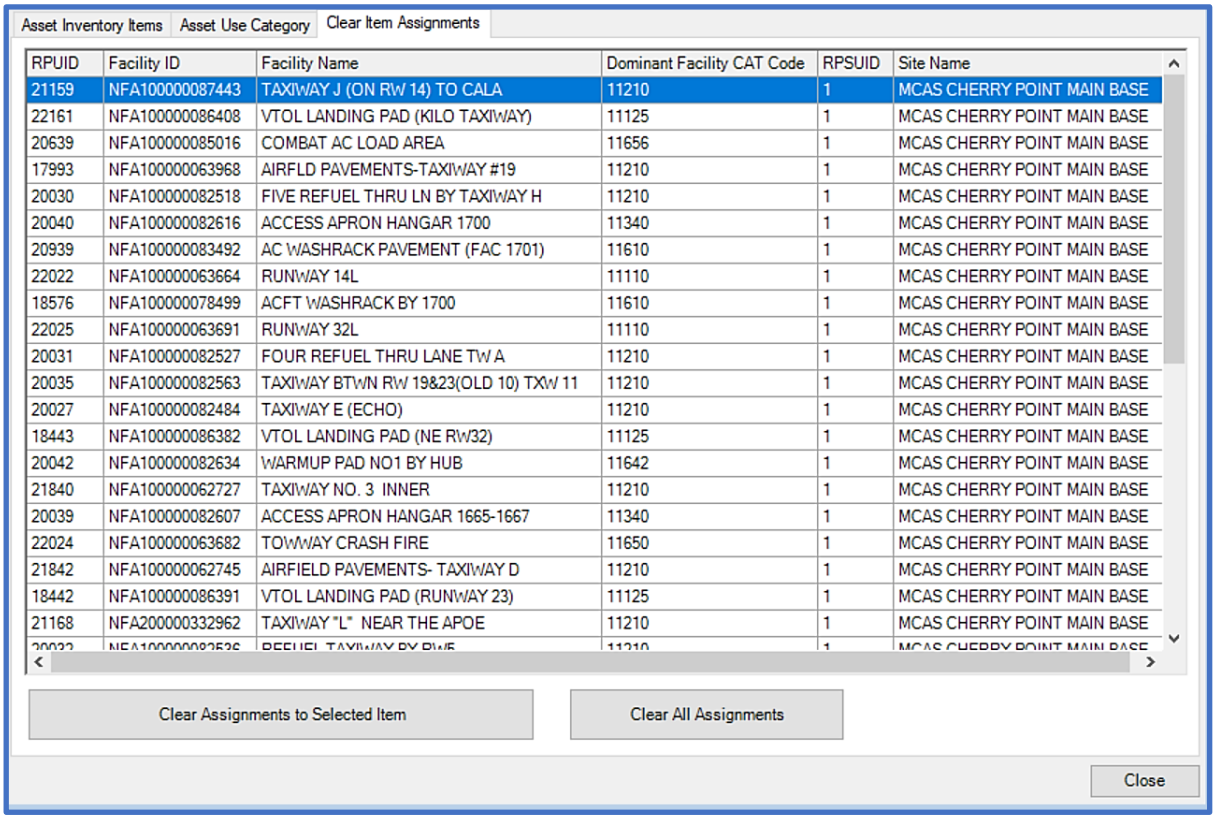
The Asset assignment tool is comprised of three tabs and a List Selector, which launches with the assignment tool to make searching for selections easier. The first tab, Asset Inventory Items, provides options to assign Asset items.



The next tab, Asset Use Category, allows you to assign Asset types based on pavement use



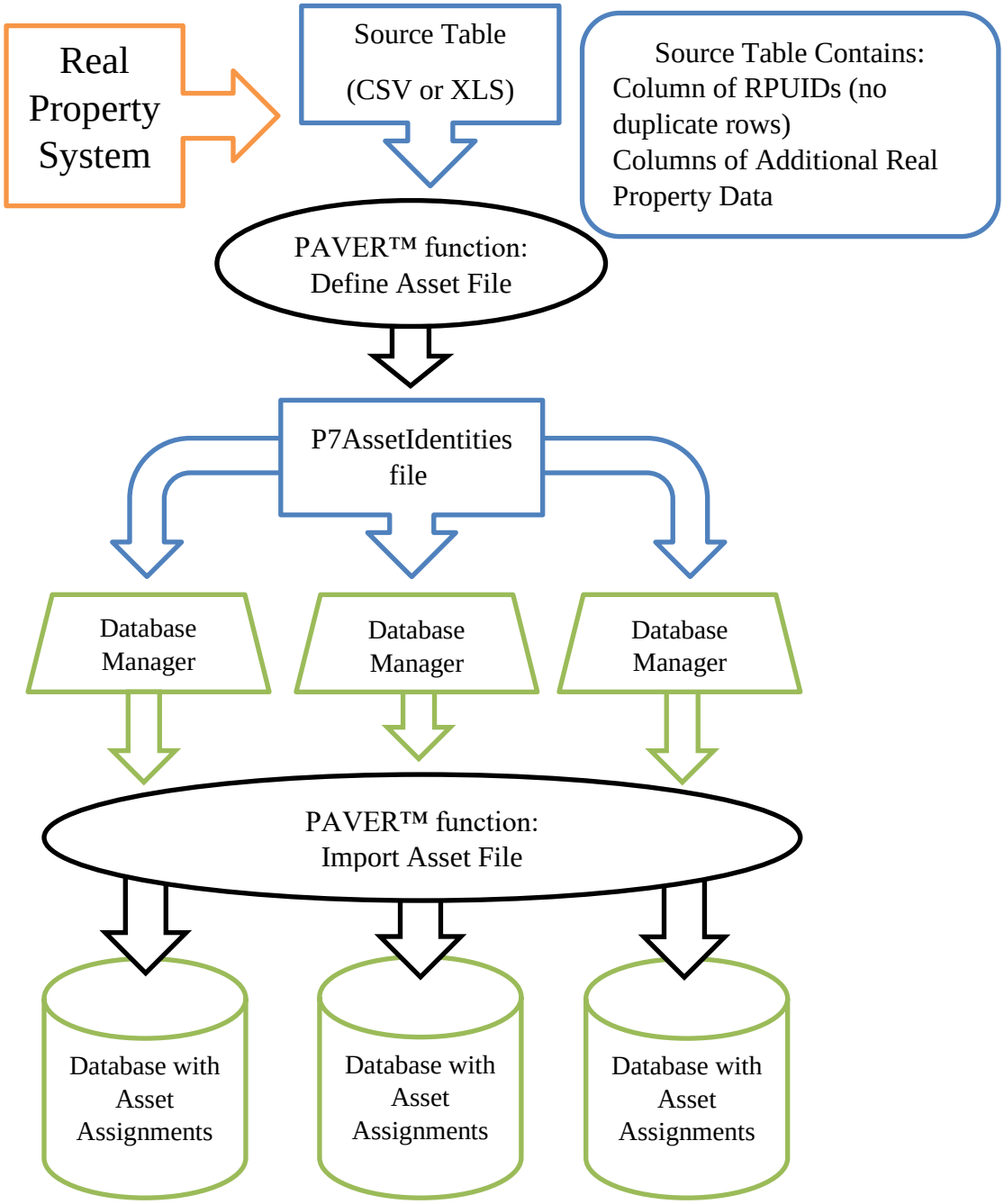
The last tab, Clear Item Assignments, gives you the ability to clear Asset item assignments. Select a row, then the Clear Assignments to Selected Item button to clear a single assignment. If you wish to remove all assignments, select the Clear All Assignments button.



RPUID	Facility ID	Facility Name	Dominant Facility CAT Code	RPSUID	Site Name
21159	NFA100000087443	TAXIWAY J (ON RW 14) TO CALA	11210	1	MCAS CHERRY POINT MAIN BASE
22161	NFA100000086408	VTOL LANDING PAD (KILO TAXIWAY)	11125	1	MCAS CHERRY POINT MAIN BASE
20639	NFA100000085016	COMBAT AC LOAD AREA	11656	1	MCAS CHERRY POINT MAIN BASE
17993	NFA100000063968	AIRFLD PAVEMENTS-TAXIWAY #19	11210	1	MCAS CHERRY POINT MAIN BASE
20030	NFA100000082518	FIVE REFUEL THRU LN BY TAXIWAY H	11210	1	MCAS CHERRY POINT MAIN BASE
20040	NFA100000082616	ACCESS APRON HANGAR 1700	11340	1	MCAS CHERRY POINT MAIN BASE
20939	NFA100000083492	AC WASHRACK PAVEMENT (FAC 1701)	11610	1	MCAS CHERRY POINT MAIN BASE
22022	NFA100000063664	RUNWAY 14L	11110	1	MCAS CHERRY POINT MAIN BASE
18576	NFA100000078499	ACFT WASHRACK BY 1700	11610	1	MCAS CHERRY POINT MAIN BASE
22025	NFA100000063691	RUNWAY 32L	11110	1	MCAS CHERRY POINT MAIN BASE
20031	NFA100000082527	FOUR REFUEL THRU LANE TW A	11210	1	MCAS CHERRY POINT MAIN BASE
20035	NFA100000082563	TAXIWAY BTWN RW 19&23(OLD 10) TXW 11	11210	1	MCAS CHERRY POINT MAIN BASE
20027	NFA100000082484	TAXIWAY E (ECHO)	11210	1	MCAS CHERRY POINT MAIN BASE
18443	NFA100000086382	VTOL LANDING PAD (NE RW32)	11125	1	MCAS CHERRY POINT MAIN BASE
20042	NFA100000082634	WARMUP PAD NO1 BY HUB	11642	1	MCAS CHERRY POINT MAIN BASE
21840	NFA100000062727	TAXIWAY NO. 3 INNER	11210	1	MCAS CHERRY POINT MAIN BASE
20039	NFA100000082607	ACCESS APRON HANGAR 1665-1667	11340	1	MCAS CHERRY POINT MAIN BASE
22024	NFA100000063682	TOWWAY CRASH FIRE	11650	1	MCAS CHERRY POINT MAIN BASE
21842	NFA100000062745	AIRFIELD PAVEMENTS- TAXIWAY D	11210	1	MCAS CHERRY POINT MAIN BASE
18442	NFA100000086391	VTOL LANDING PAD (RUNWAY 23)	11125	1	MCAS CHERRY POINT MAIN BASE
21168	NFA200000332962	TAXIWAY "L" NEAR THE APOE	11210	1	MCAS CHERRY POINT MAIN BASE

7.4 Centralized Asset Management

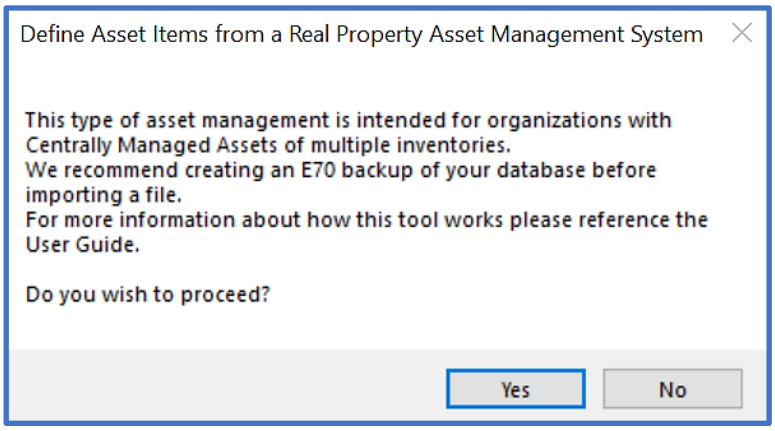
Asset files can be created for distribution or imported using the Centralized Asset Management tools. Centralized Asset management is intended for organizations with centrally managed Assets of multiple inventories. See the flow chart below for a visualization of the process.


Real Property System
Source Table
(CSV or XLS)
Source Table Contains:
Column of RPUIDs (no duplicate rows)
Columns of Additional Real Property Data
PAVER™ function:
Define Asset File
P7AssetIdentities file
Database Manager
Database Manager
Database Manager
PAVER™ function:
Import Asset File
Database with Asset Assignments
Database with Asset Assignments
Database with Asset Assignments

7.4.1 Create Asset File for Distribution

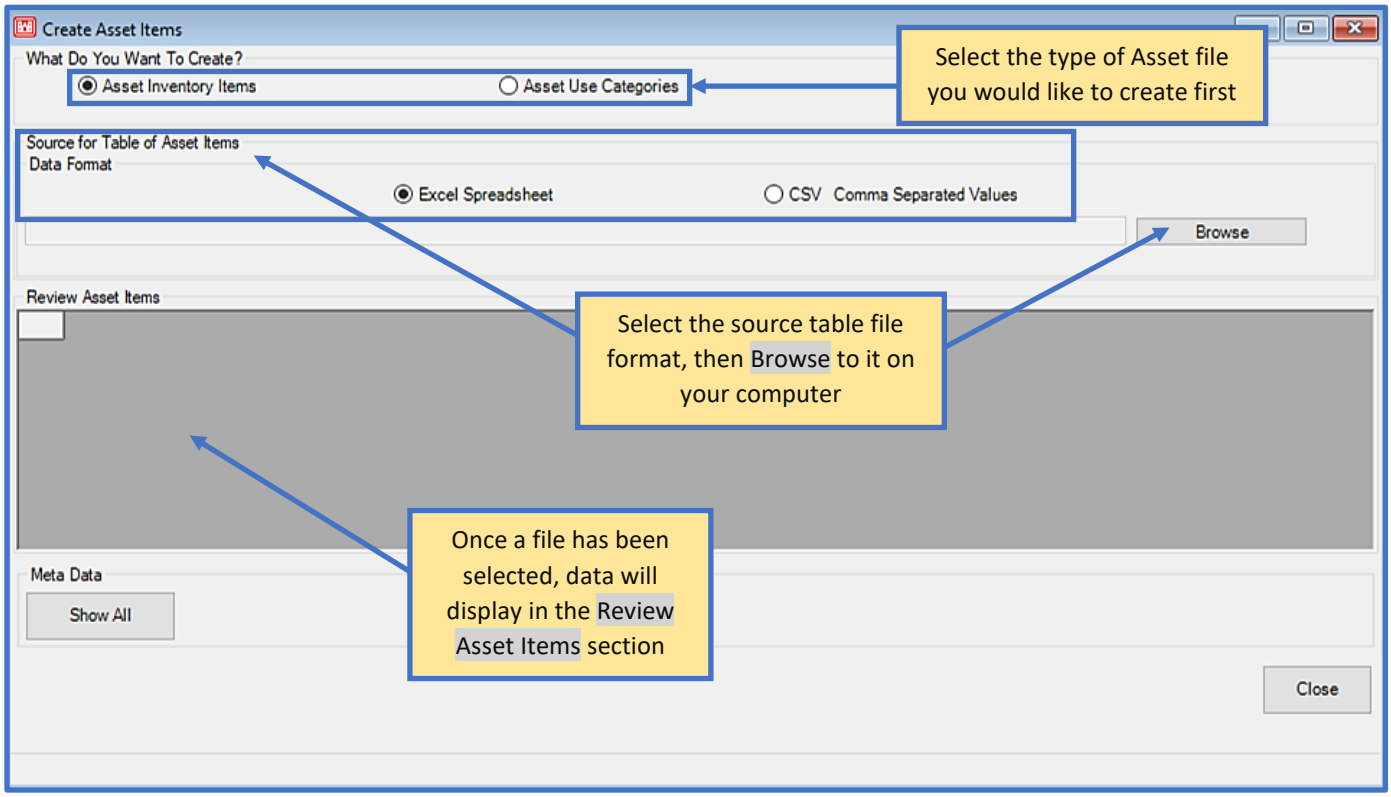
Prior to using the Centralized Asset Management tools, the organization's appointed user should create a source table from the Real Property system; a single Excel spreadsheet containing all desired RPUIDs (Real Property Unique ID) to be tracked. Be sure to create an .e70 backup of your database before importing a file (File > Export Open Pavement Database). A message displays after selecting Create Asset File for Distribution, asking if you would like to proceed.

Note: This function should only be accessed by a single user within an organization to prepare the organization's Asset items.



The Create Asset Items form supports CSV and XLS file formats. The file to be imported must contain a column of RPUIDs which does not duplicate row values, this column should be named RPUID. Additional columns from Real Property systems should also be included for import to PCASE 7, as this table will replace the Site and Facility system tables. Recommended columns include: RPUID, Site Name, Facility ID, Facility Name, Dominant CATCD, or any other identifiers. Once the source table has been created and formatted, it is ready to be converted into a P7AssetIdentities file.

Note: Only include desired data in the exported file, as hidden rows and columns will also be imported. Filtering on FACs applicable to PCASE is advised, if your system supports it.

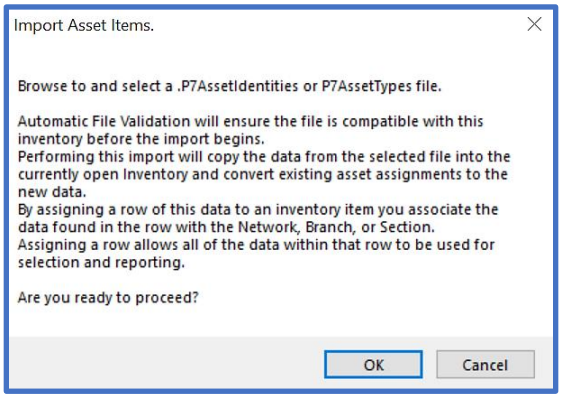


To proceed, select the RPUID column name and optionally the Dominant CATCD column. Select Show All to select from all columns. *Note: If using Show All, edit duplicate values in their desired RPUID column. The program will only save the first row with each value in the selected RPUID column.* After the P7AssetIdentities file has been created, it can now be imported into the appropriate database.

Note: If the desired column name is not available within the RPUID drop-list, the program has found duplicate values in the column.

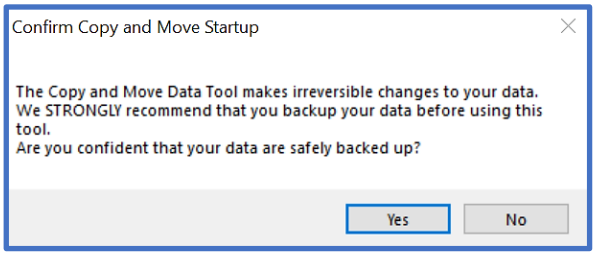
7.4.2 Import Asset File

Ensure the database that you would like to import the P7AssetIdentities file into is currently open. Selecting the Import Asset File tool will prompt an informative message, asking you to confirm prior to proceeding. PCASE 7 will now compare the existing Asset information in the inventory to the file you're attempting to import and will only proceed with the process if all of the current Asset RPUIDs match the IDs in the file.

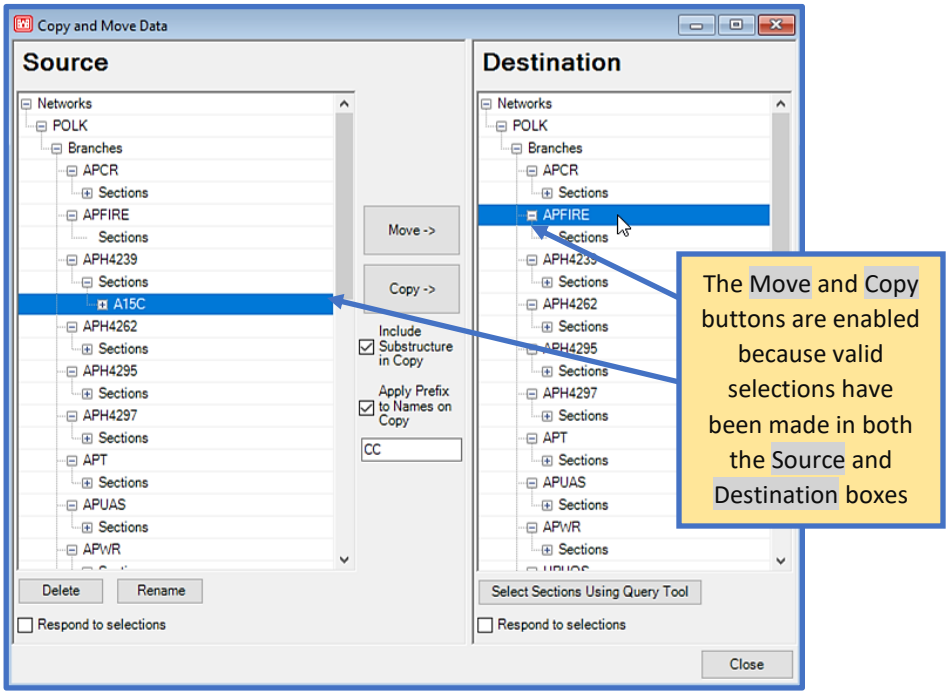


7.5 Copy and Move Data

Prior to using the Copy and Move Data tool, first ensure that your data is backed up as this tool makes irreversible changes to data.



Select the inventory item you wish to move or copy from the Source box, then select the Destination for the inventory item you wish to move or copy. The Move button relocates an item to a specified location (Destination), while the Copy button leaves the original item in its location and places a copy in the specified Destination. Both the Move and Copy buttons remain disabled until an acceptable selection combination has been achieved. All data movement is restricted to the data within the open database. If you wish to move data between databases, use the Combine Inventories tool within the File menu. The Copy and Move Data tool also allows deletion and renaming of inventory data located in the Source box. The Select Sections Using Query Tool button allows you to select a subset of data. The Respond to selections checkbox links the Copy and Move Data tool to Selectors, so that you can make your selections using the Selector tools.

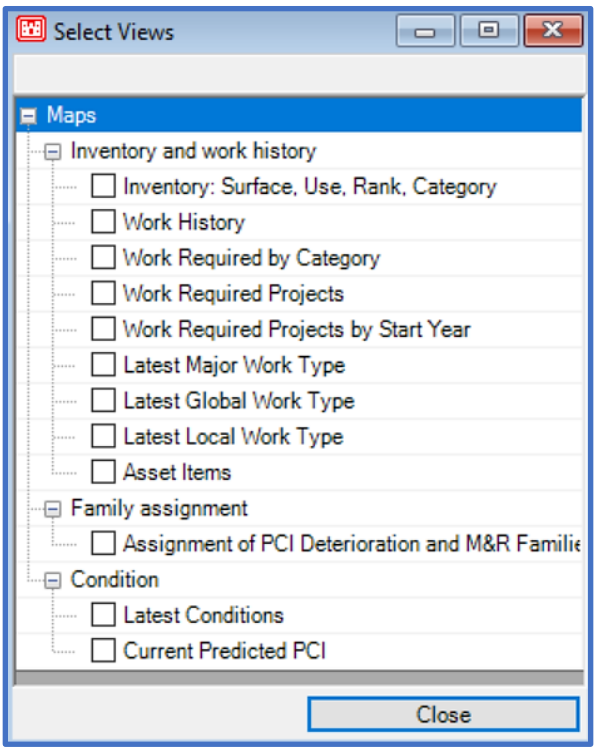


8 Reports

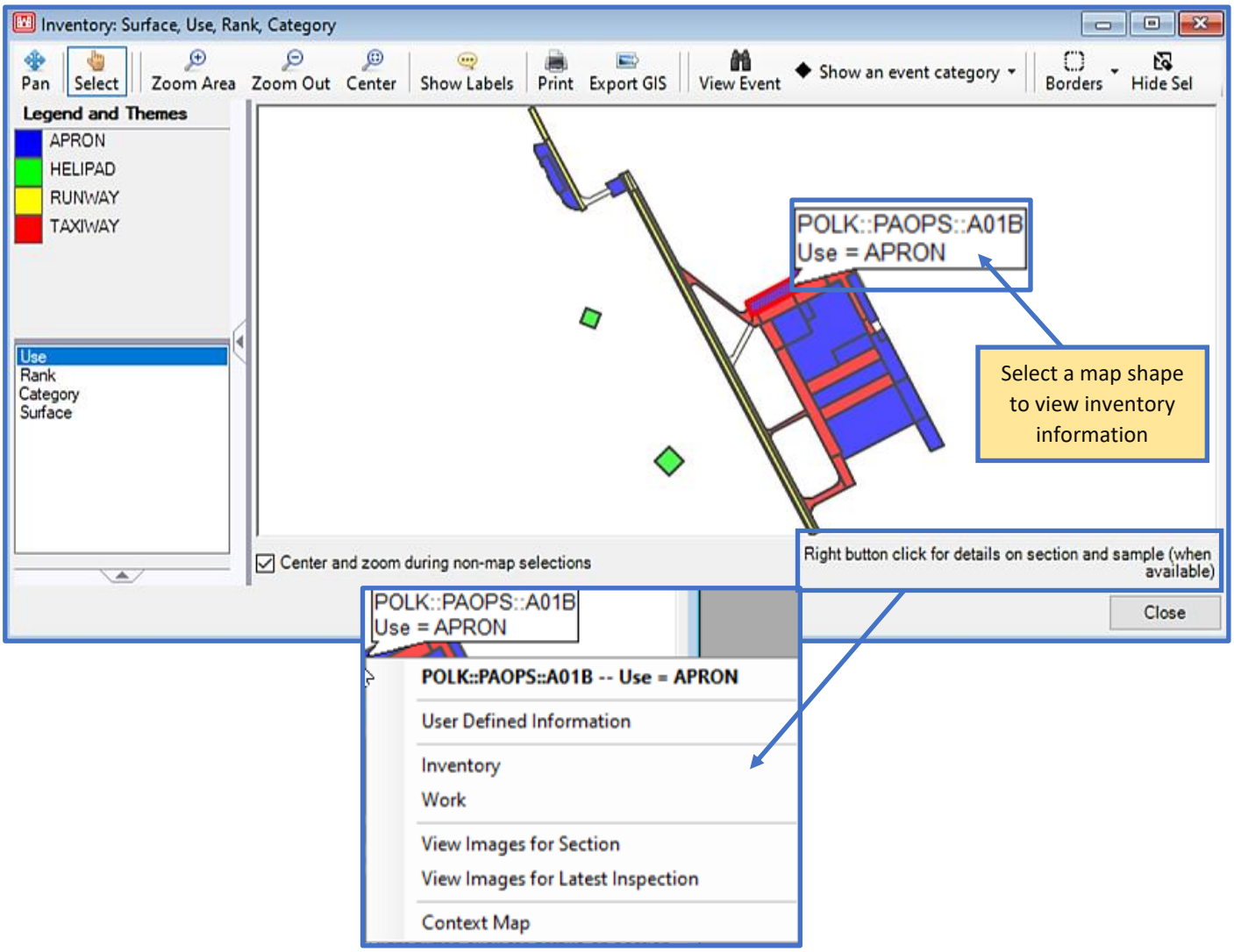
View and filter data in a variety of different ways using the Reports tools. GIS Reports offers multiple GIS map views based on the current inventory and associated data. Summary Charts allow you to select the X Axis and Y Axis from a drop-list of options, as well as Condition criteria for the chart. Enterprise Summary Charts provides options to generate reports grouped by selected attributes and condition type. Standard Reports contains specific report types to choose from, and also allows you to select a subset of the inventory using the Query Tool. Finally, User Defined Reports give you the ability to select from a list of Memorized Reports as well as create a new custom report.

8.1 GIS Reports

The GIS Reports tool provides a tree of GIS map views, which you can select from. Multiple maps can be open simultaneously. Click on an item within the tree to view data.

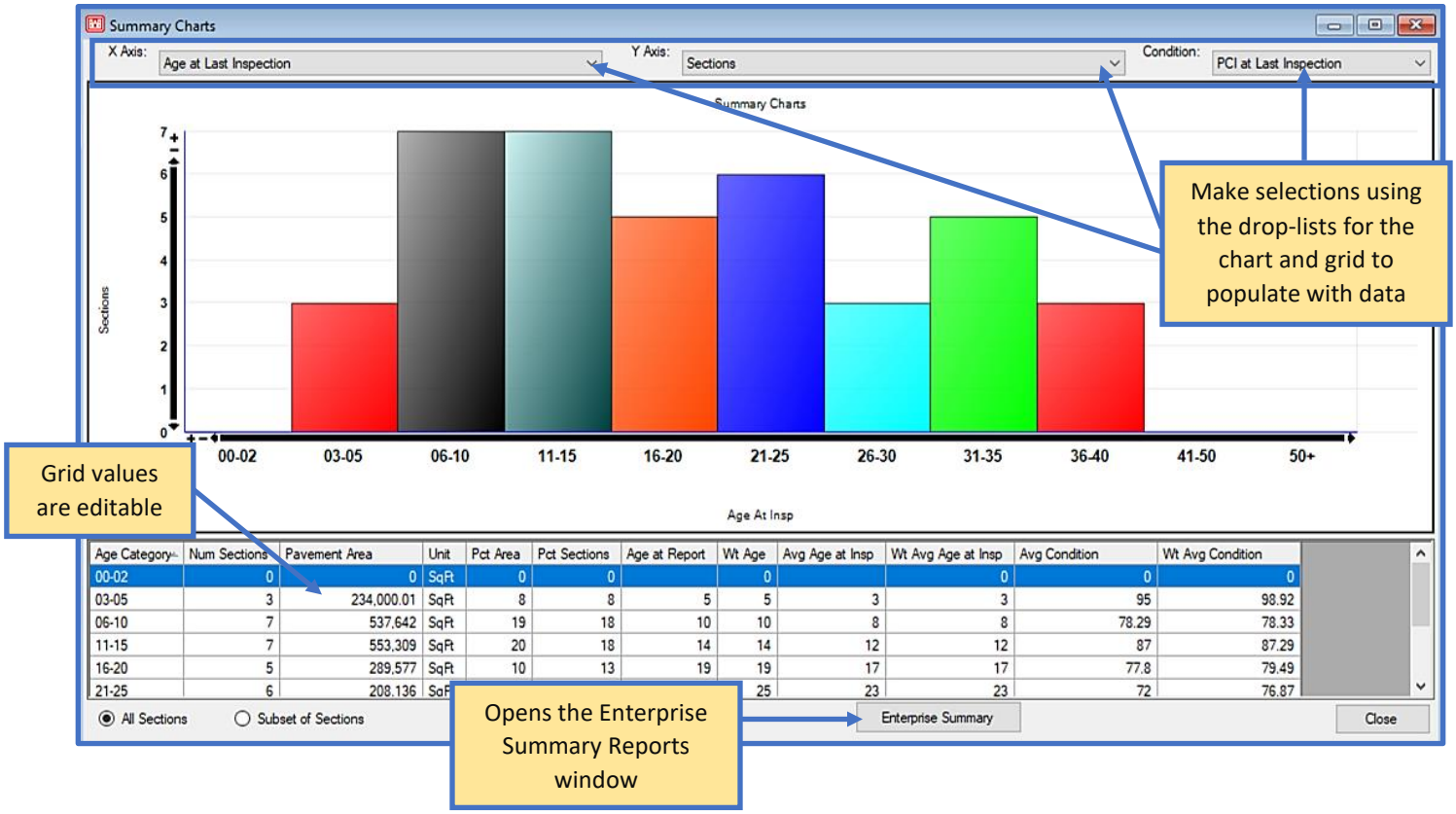


Below is an example of the Inventory: Surface, Use, Rank, Category view. For more information on GIS window functionalities, refer to Section 7.2 GIS Assignment.



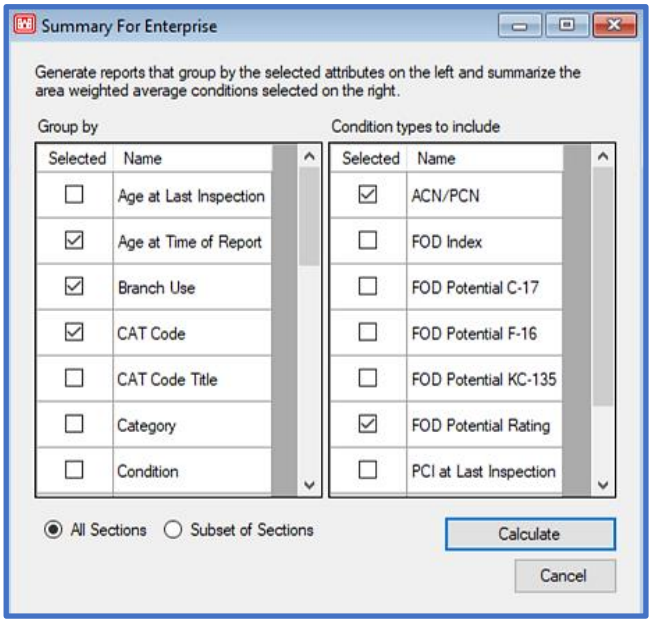
8.2 Summary Charts

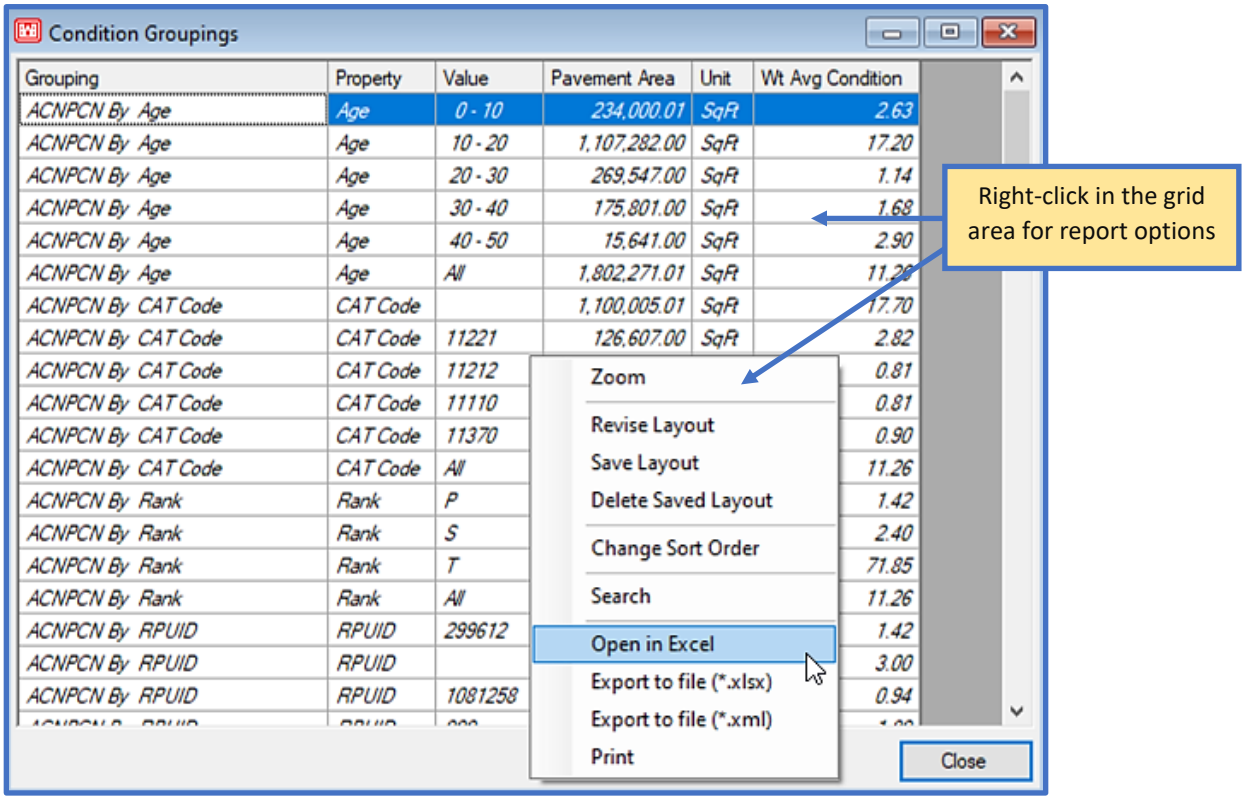
Graph and compare two attributes of a database using Summary Charts. Select categories to represent the X and Y axes using the associated drop-lists, then select a condition index from the Condition drop-list. *Note: For the chart to work properly, you must have condition data available for the selected index.* The chart will populate with data after you've made your selections. Below is an example of a Summary Chart. Right-click within the chart area for zoom, print, save, and graph property options.



8.3 Enterprise Summary Reports

Enterprise Summary Reports are a reporting feature that allows you to select a Subset of Sections or All Sections from the currently open database to group by a selection of properties, as well as a selection of condition types for weighted average condition parameters. After you've made selections from both columns, click on the Calculate button to generate results in the Condition Groupings window.





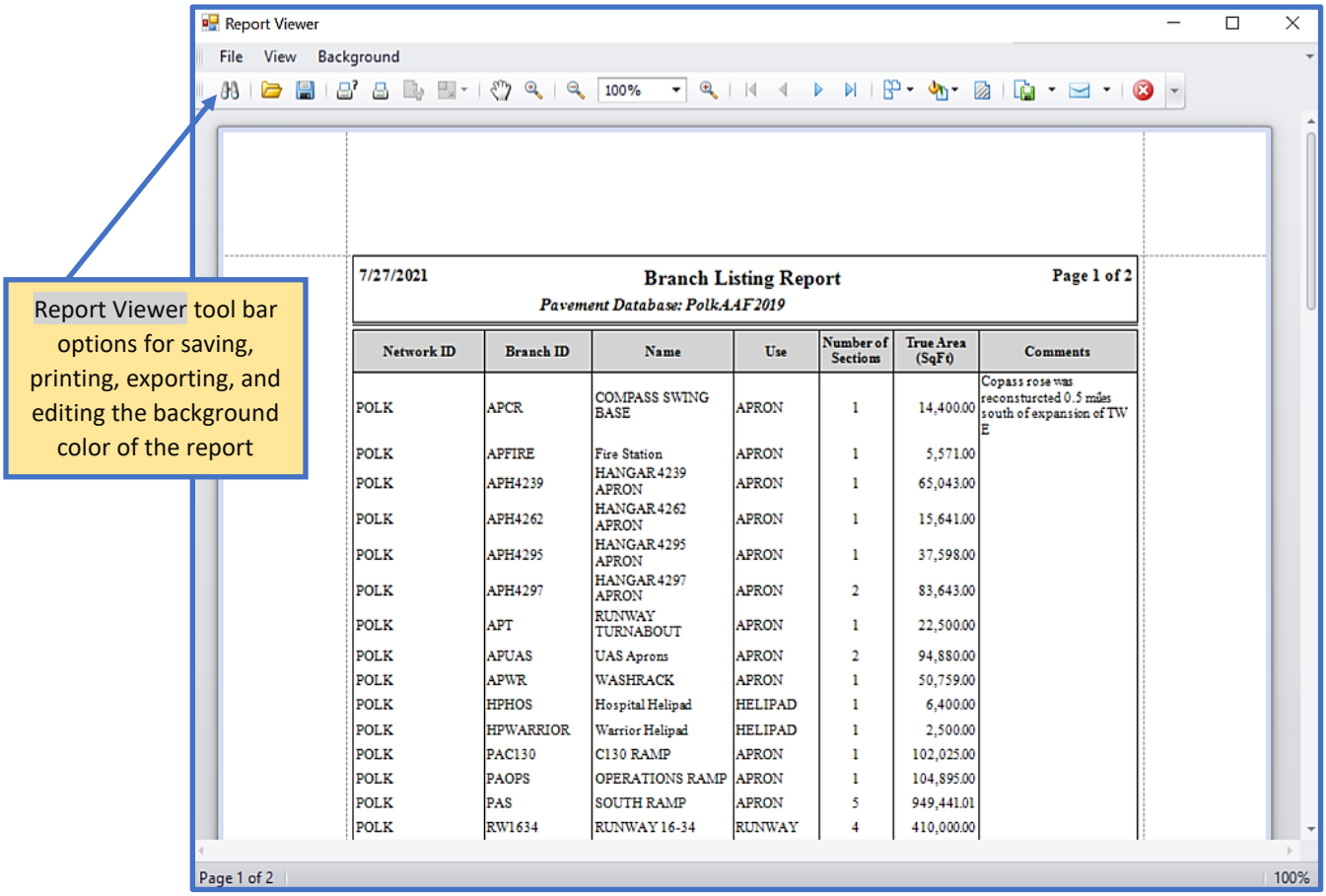
8.4 Standard Reports

The Standard Reports tool provides five set report options.

- Branch Listing Report: Produces a list of all Branches within the database and associated information (eg., usage, number of Sections, total area, etc.), followed by a summary of Network, Branch, Section, Total True Area, and Average Branch True Area totals.
- Work History Report: A Section-by-Section report of all work completed within an inventory; over the life of the database. There is a summary at the end of the report which displays Section Count, Area Total, Thickness Avg., and Thickness STD totals for each type of work in a pavement history.
- Branch Condition Report: Displays both the average and weighted average condition for each Branch, including standard deviations. After this report has been selected, a list of condition Methods will populate. Choose an item and it will move into the Selected box, the Execute button will also enable so you can run the report. A summary of the Branch condition data is provided at the end of the report.
- Section Condition Report: Same report format as the Branch Condition Report, except data is displayed at the Section level. Report data is summarized on the last page.

- Linear Segmentation Report: Produces a report containing Real Property Asset information in the database such as RPUIDs, weighted average condition, area, and CATCDs. *Note: Show Asset Items (File > Database Properties > Preferences) must be turned on in order for this report to appear as an option in the list of Standard Reports.*

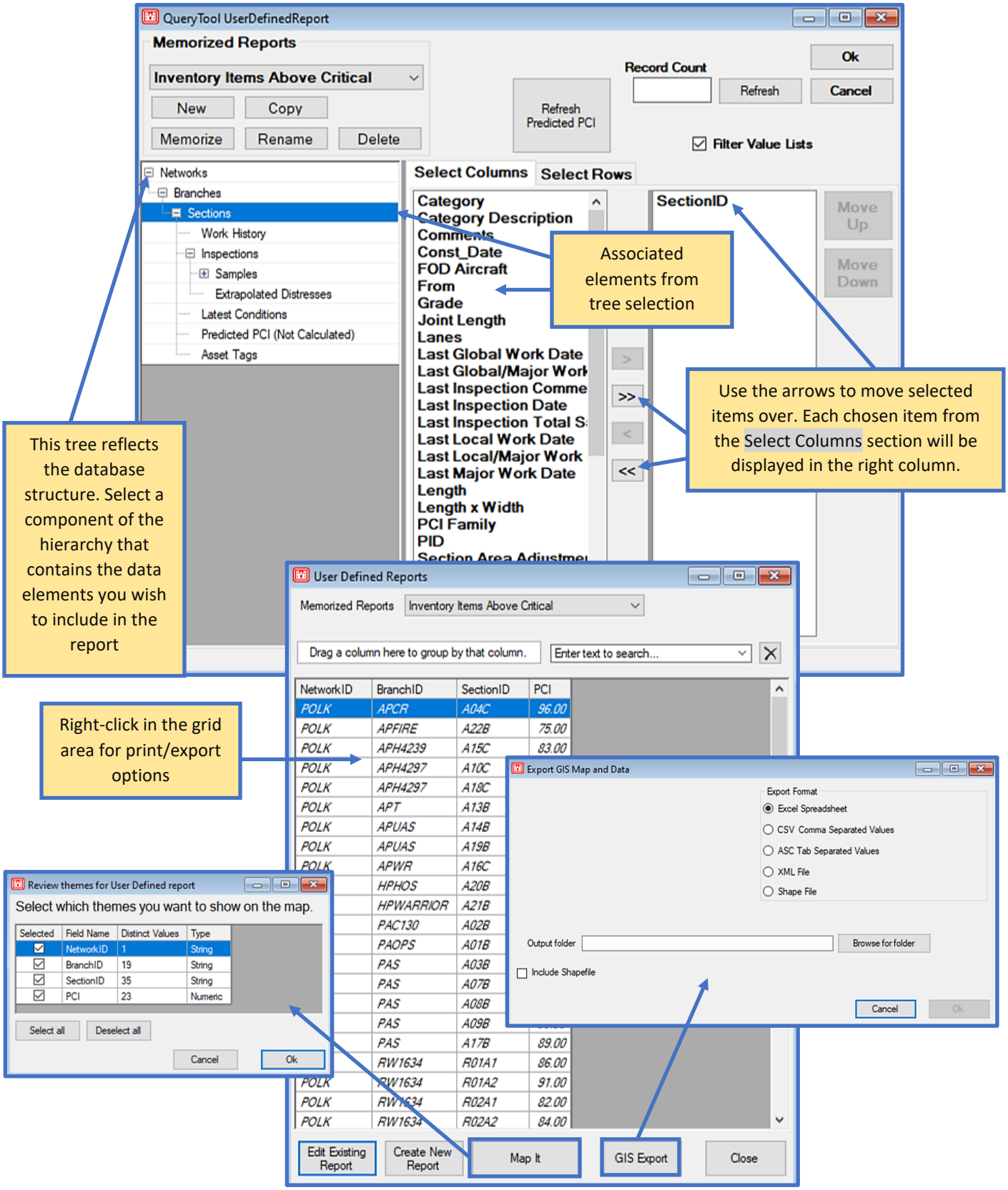
You can include All Items in each report, or use the Query Tool to build a Section subset with the Build Selection Using Query Tool option. Click on the Execute button to formulate a report. The Report Viewer contains a tool bar with report options.



Network ID	Branch ID	Name	Use	Number of Sections	True Area (SqFt)	Comments
POLK	APCR	COMPASS SWING BASE	APRON	1	14,400.00	Copass rose was reconsturcted 0.5 miles south of expansion of TW E
POLK	APFIRE	Fire Station	APRON	1	5,571.00	
POLK	APH4239	HANGAR 4239 APRON	APRON	1	65,043.00	
POLK	APH4262	HANGAR 4262 APRON	APRON	1	15,641.00	
POLK	APH4295	HANGAR 4295 APRON	APRON	1	37,598.00	
POLK	APH4297	HANGAR 4297 APRON	APRON	2	83,643.00	
POLK	APT	RUNWAY TURNABOUT	APRON	1	22,500.00	
POLK	APUAS	UAS Aprons	APRON	2	94,880.00	
POLK	APWR	WASHRACK	APRON	1	50,759.00	
POLK	HPHOS	Hospital Helipad	HELIPAD	1	6,400.00	
POLK	HPWARRIOR	Warrior Helipad	HELIPAD	1	2,500.00	
POLK	PAC130	C130 RAMP	APRON	1	102,025.00	
POLK	PAOPS	OPERATIONS RAMP	APRON	1	104,895.00	
POLK	PAS	SOUTH RAMP	APRON	5	949,441.01	
POLK	RW1634	RUNWAY 16-34	RUNWAY	4	410,000.00	

8.5 User Defined Reports

View Memorized Reports, create a new report, or edit an existing report using the User Defined Report tools. The Memorized Reports drop-list contains previously created/saved User Defined reports in the database. Select a report and the associated data will populate in a grid below, additional GIS map/export options will also appear below the grid. To begin creating a new report, click on the Create New Report button to launch the Query Tool. Select the New button to name the new report, then proceed with choosing elements for the report. Click on Memorize to save the report, then select Ok to exit the Query Tool and return to User Defined Reports.


QueryTool UserDefinedReport
Memorized Reports
Inventory Items Above Critical
New
Copy
Memorize
Rename
Delete
Refresh Predicted PCI
Record Count
Refresh
Ok
Cancel
Filter Value Lists
Networks
Branches
Sections
Work History
Inspections
Samples
Extrapolated Distresses
Latest Conditions
Predicted PCI (Not Calculated)
Asset Tags
Select Columns
Select Rows
Category
Category Description
Comments
Const_Date
FOD Aircraft
From
Grade
Joint Length
Lanes
Last Global Work Date
Last Global/Major Work
Last Inspection Comme
Last Inspection Date
Last Inspection Total S
Last Local Work Date
Last Local/Major Work
Last Major Work Date
Length
Length x Width
PCI Family
PID
SectionID
Move Up
Move Down
Associated elements from tree selection
Use the arrows to move selected items over. Each chosen item from the Select Columns section will be displayed in the right column.
This tree reflects the database structure. Select a component of the hierarchy that contains the data elements you wish to include in the report
User Defined Reports
Memorized Reports
Inventory Items Above Critical
Drag a column here to group by that column.
Enter text to search...
NetworkID
BranchID
SectionID
PCI
Right-click in the grid area for print/export options
Export GIS Map and Data
Export Format
Excel Spreadsheet
CSV Comma Separated Values
ASC Tab Separated Values
XML File
Shape File
Output folder
Browse for folder
Include Shapefile
Cancel
Ok
Review themes for User Defined report
Select which themes you want to show on the map.
Selected
Field Name
Distinct Values
Type
NetworkID
BranchID
SectionID
PCI
Select all
Deselect all
Edit Existing Report
Create New Report
Map It
GIS Export
Close

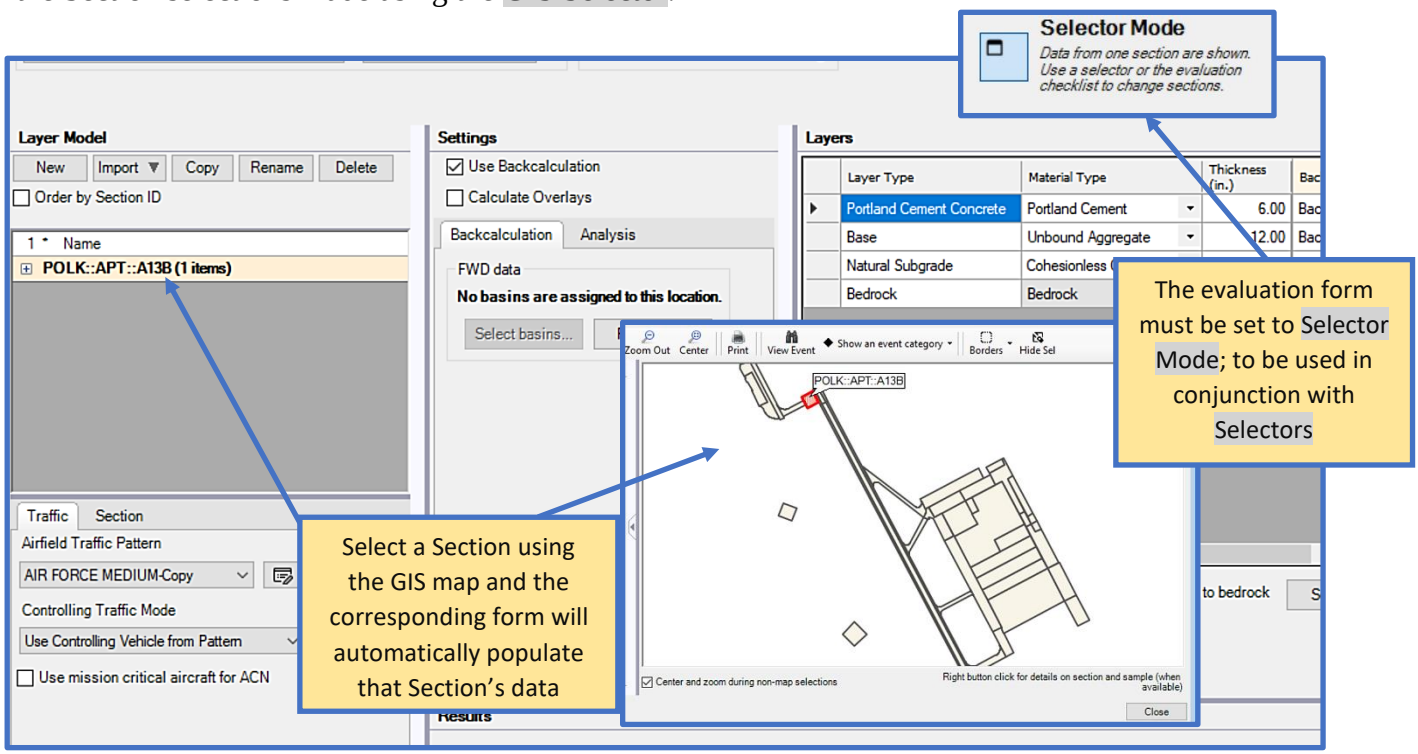
If you wish to edit an existing report; select the report from the Memorized Reports drop-list, then click on the Edit Existing Report button to launch the Query Tool. Once edits have been made, click on Ok and you will be prompted to save your changes. Report changes will be reflected the next time the report is ran.

9 Selectors

The Selectors menu is comprised of options to help you narrow the scope of an inventory by allowing you to choose specific portions to work with, in a number of different ways. Areas of the program that require you to specify a component of the inventory will respond to the input received from the selector tools. You can set a program-wide Default selector in Preferences > PAVER/PCASE Defaults > Overview.

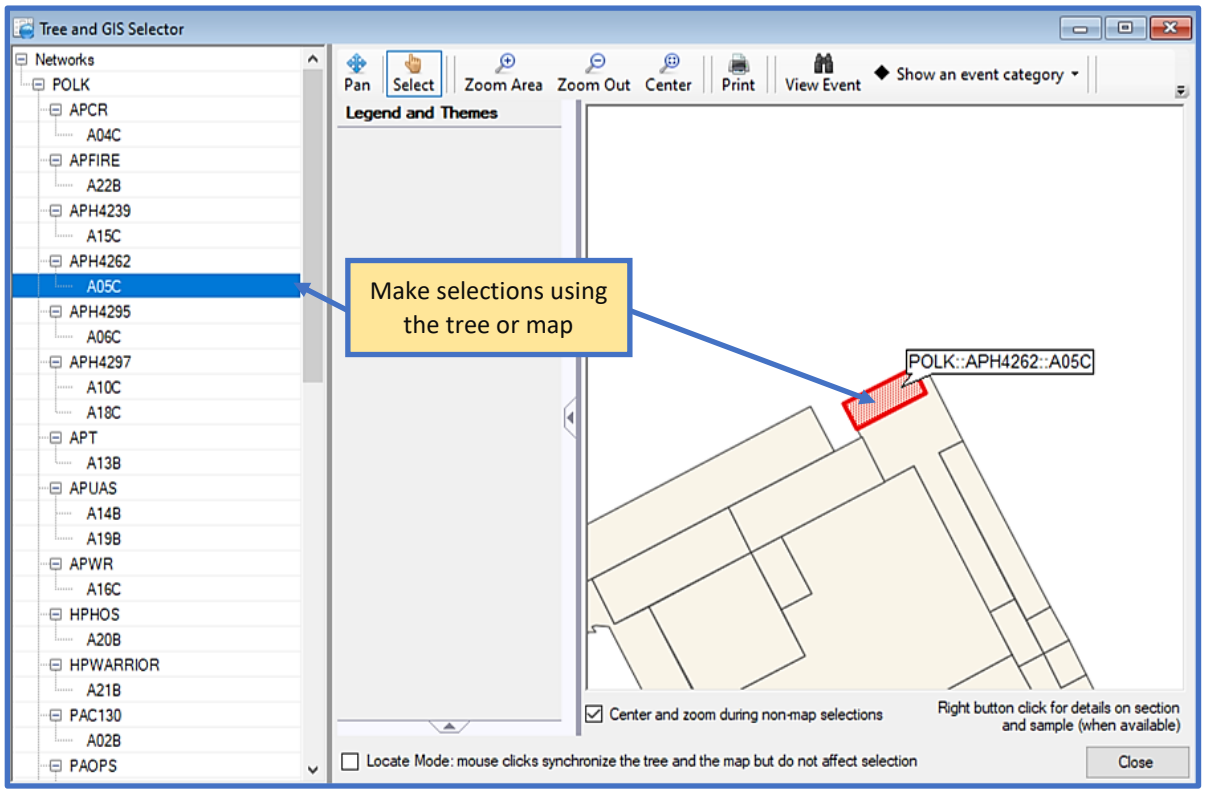
9.1 GIS Selector

If a GIS linkage has been established in PCASE 7 or PAVER™ using the GIS Assignment tool, the GIS Selector can be used to navigate to Sections of the inventory by clicking on map shapes. When any of the PCASE 7 evaluation modules are in Selector Mode, the forms will respond to the Section selections made using the GIS Selector.



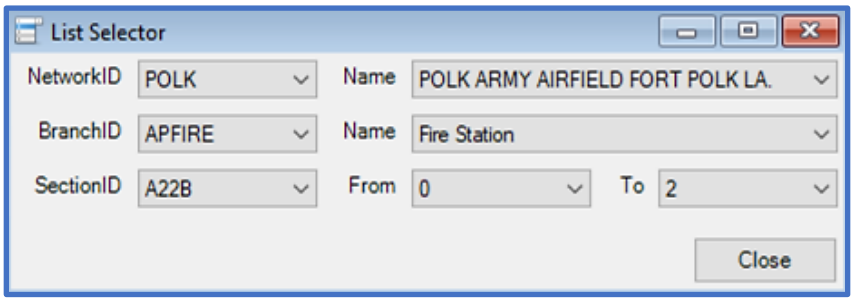
9.2 GIS/Tree Selector

The GIS/Tree Selector is simply a combination of the Tree Selector and GIS Selector displayed in one window. This allows you to select an inventory item using the simplest method for that particular item. For example, if you know only the location of the pavement then the GIS Selector would be most useful. If you need to trace through the hierarchy of the inventory; using the Tree Selector would be the more logical choice.



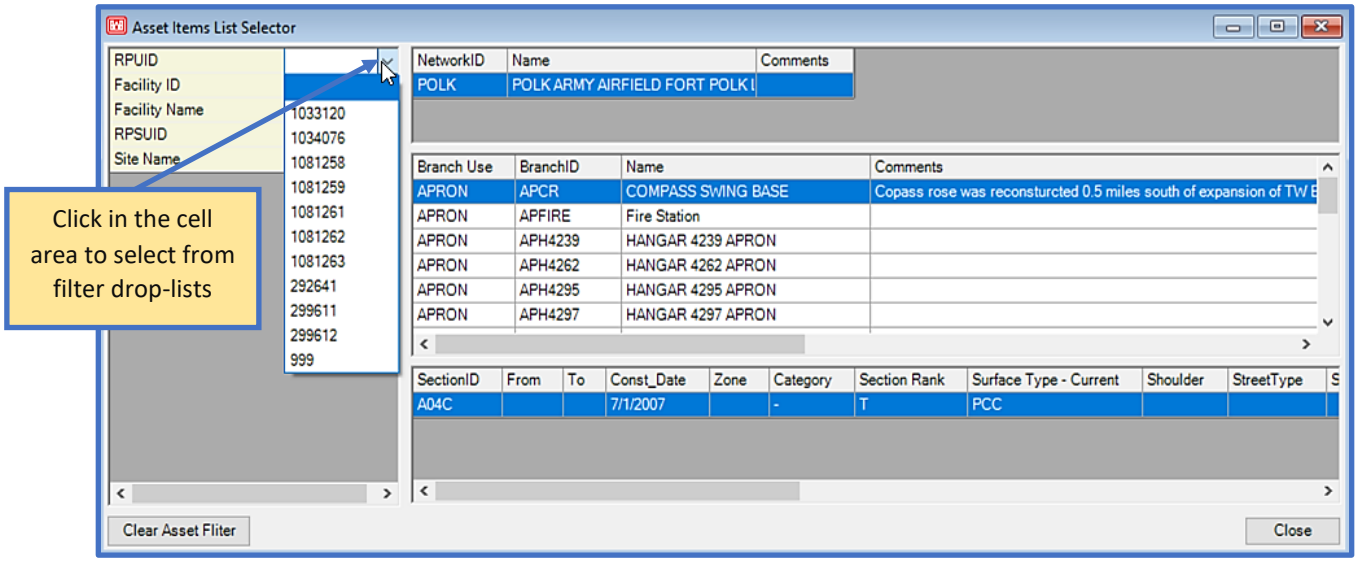
9.3 List Selector

The List Selector consists of a series of drop-lists that help you navigate to a specific point in the inventory. While in Selector Mode, the APE evaluation and LEEP evaluation forms will respond to selections made using the List Selector. The FWD data and DCP data forms will also work with the List Selector (while in Selector Mode) as long as there is data assigned to Sections.



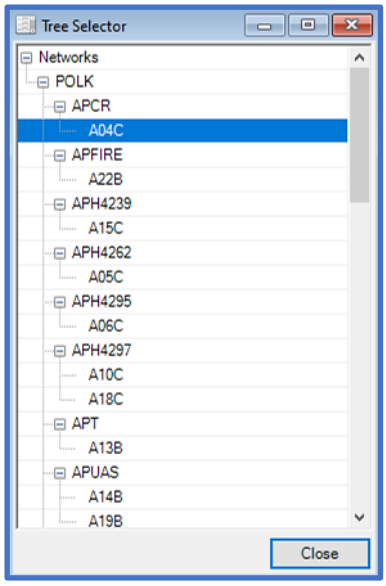
9.4 Asset List Selector

The Asset List Selector tool will only be visible in the Selectors menu if Show Asset Items is turned on in Database Properties. The Asset List Selector works in the same manner as the other Selectors, only it gives you the ability to select Sections based on Real Property Asset filters. Select a row to navigate to that location. A filter can be applied (left-side of grid rows) using the drop-lists next to the items listed in the yellow space, Clear Asset Filter will reset any filters you've applied.



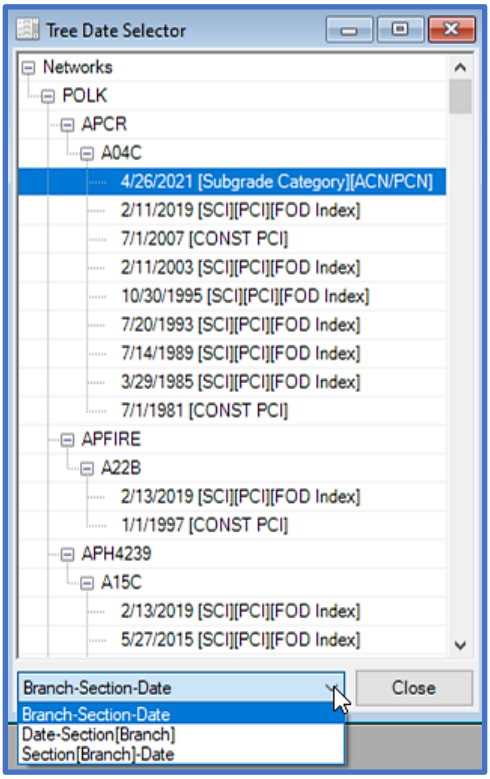
9.5 Tree Selector

The tree structure used in the Tree Selector simulates a Windows file structure and is used throughout PCASE 7. Move through the hierarchy of the inventory structure by moving down the tree, until you've arrived at the desired location.



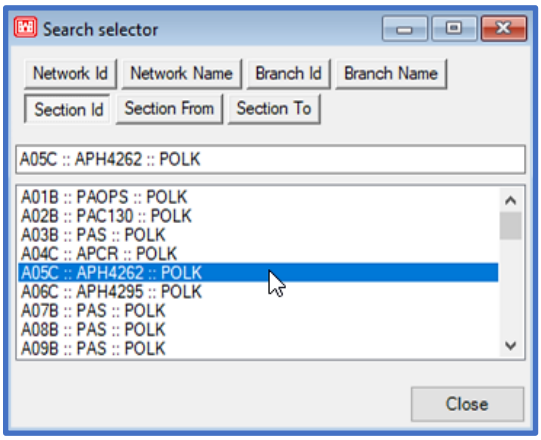
9.6 Tree Date Selector

The Tree Date Selector lists work items and inspections by date. Selecting a construction date within the tree will select the corresponding Section. The drop-list at the bottom of the window provides options to change the hierarchy of the tree.



9.7 Search Selector

Search through a database inventory based on seven predefined categories. Click on one of the tab buttons across the top of the form to view related items, and make your selections from the box below. The currently selected item will display within the field above the list box.

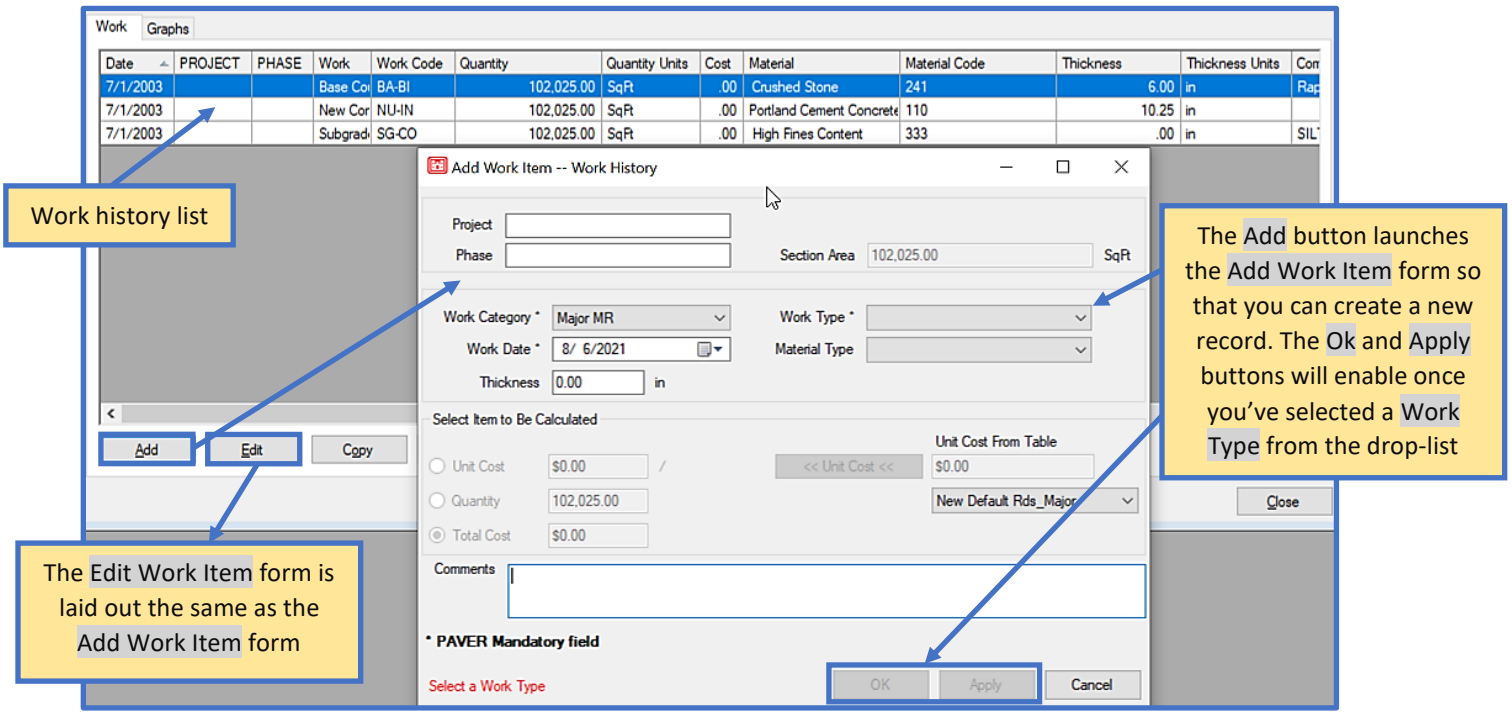


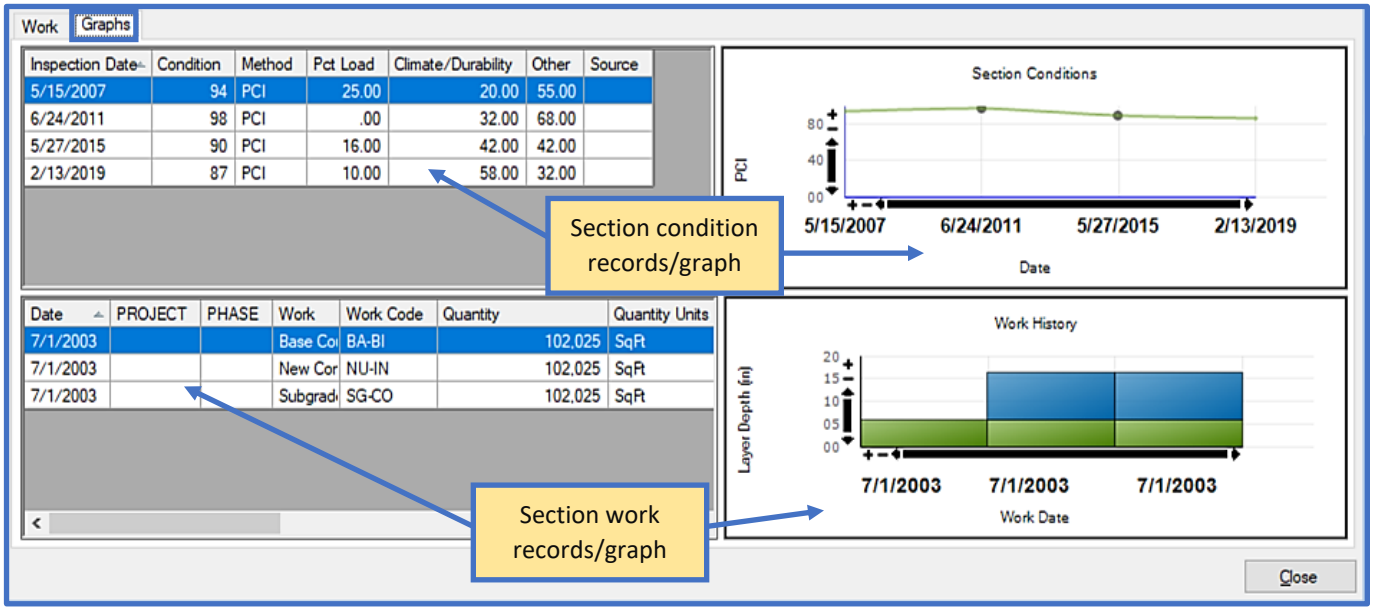
10 Work

The Work menu consists of tools that give you the ability to manage pavement maintenance, repair, and construction activity.

10.1 Work History

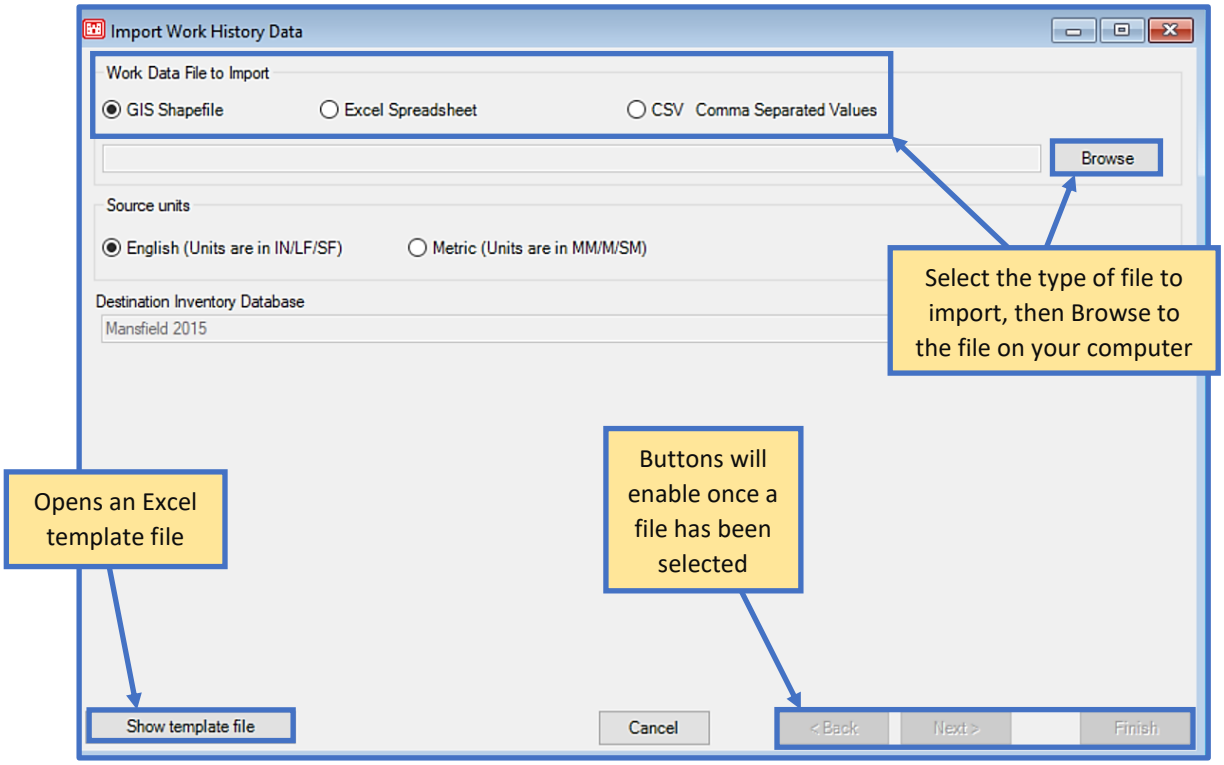
In order to accurately predict future pavement performance, maintenance requirements, cost, and inspection schedule; the system must have an accurate account of the last construction date for each Section. PCASE 7 updates the last construction date for the pavement Section, to correspond with the most recent M&R. The Work tab provides an interface for easily entering and managing work history data for Sections. The Graphs tab contains a graphic component which presents charts for each Section; relating condition to work history.

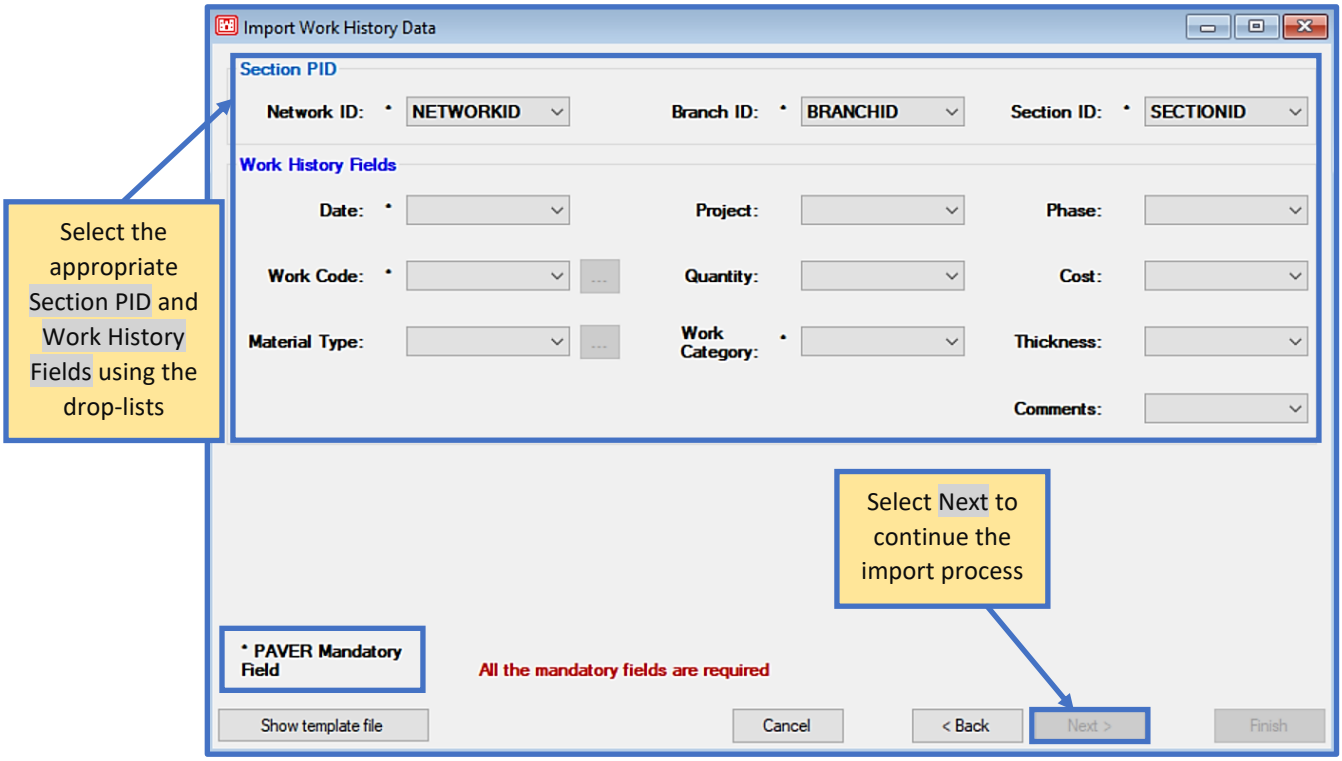




10.2 Add Work History from GIS/Tabular Data

Import work history from a GIS shapefile or tabular report using the Add Work History from GIS/Tabular Data tool. The process for using this tool is very similar to the Add Inventory from GIS/Tabular data tool (Section 2.8).





Note: Only specific values are allowed in the Work Category column within the tabular data file. The allowable values are as follows:

"Localized MR"

"LOCALIZED", "LOCAL", "LOCALIZED MR", "LOCALIZEDMR"

"Global MR"

"GLOBAL", "GLOBAL MR", "GLOBALMR"

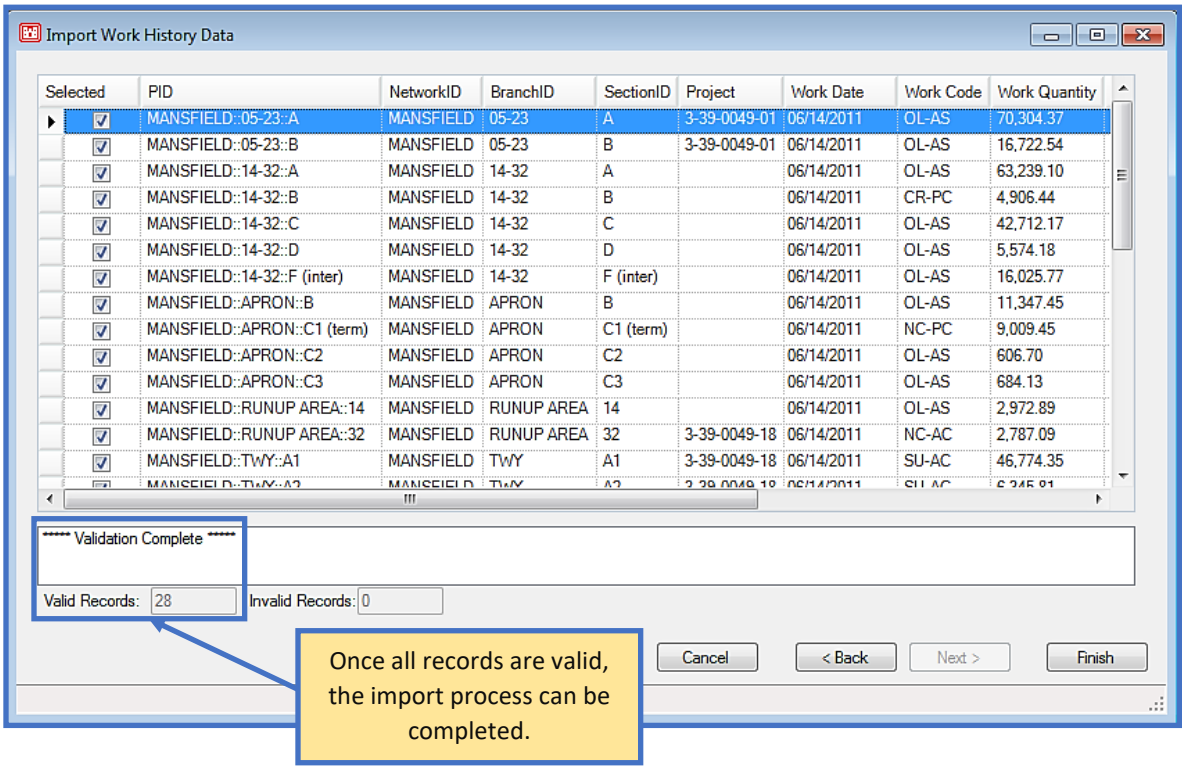
"Major MR"

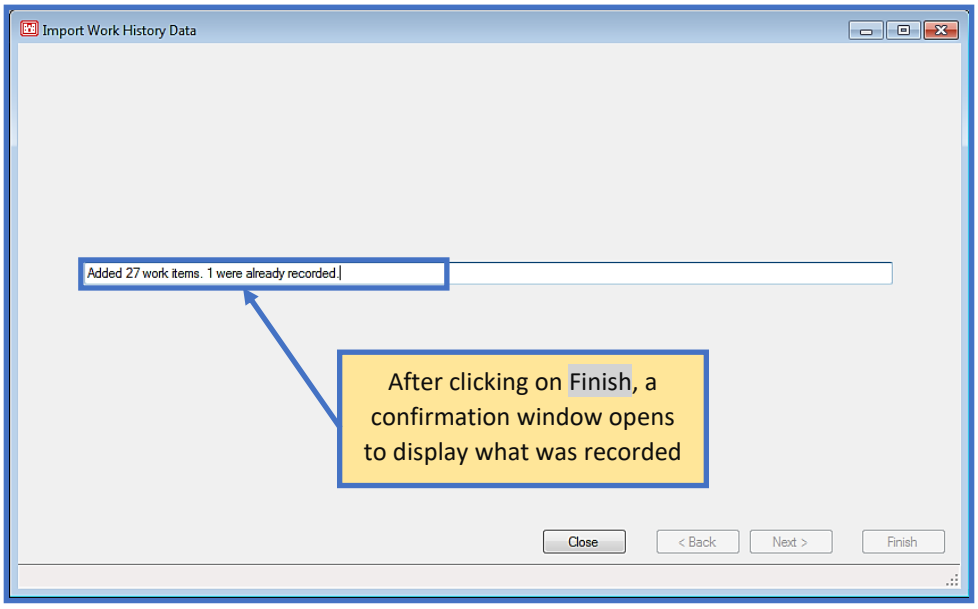
"MAJOR", "MAJOR MR", "MAJORMR"

"Layer Construct"

"LAYER", "LAYER CONSTRUCT", "LAYER CONSTRUCTION"

The results of the import will be displayed in the next window. Validation results below the grid confirms the number of valid or invalid records, so that you can review and make corrections as needed. Select Finish once validation has been completed to finalize the import process.



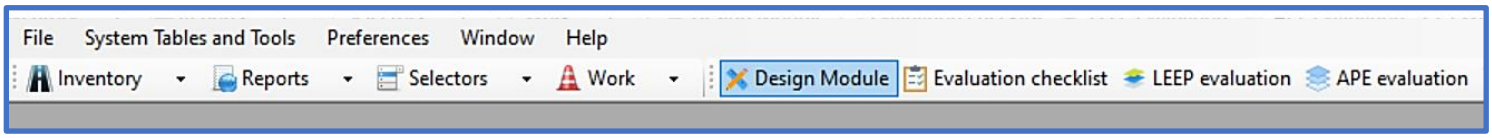


11 Design Module

Prior to beginning a new design project, ensure that you have opened or created a database to store the design project within (database name is displayed on the bottom-left of the main window). For instructions on how to import or create a database; reference Chapter 2 File Menu.

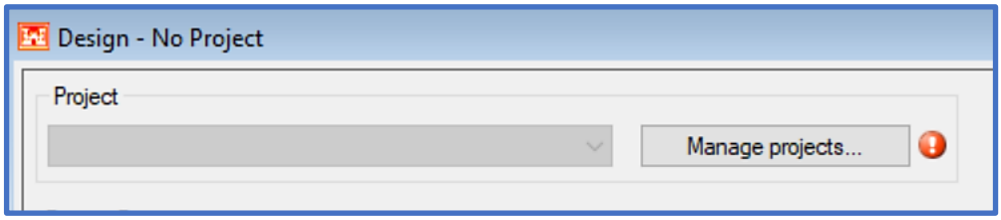
11.1 Getting Started

Select Design Module on the PCASE 7 tool bar to get started with Design.

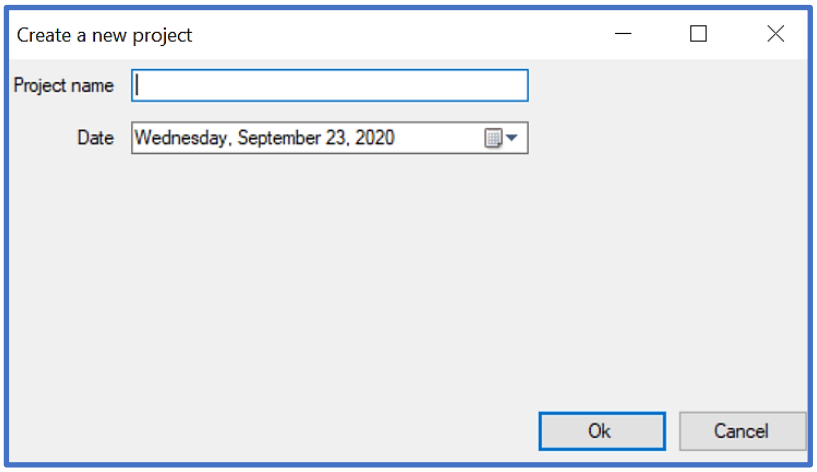


11.2 Project Properties

When the Design Module opens for the first time, the only option is to select Manage projects...

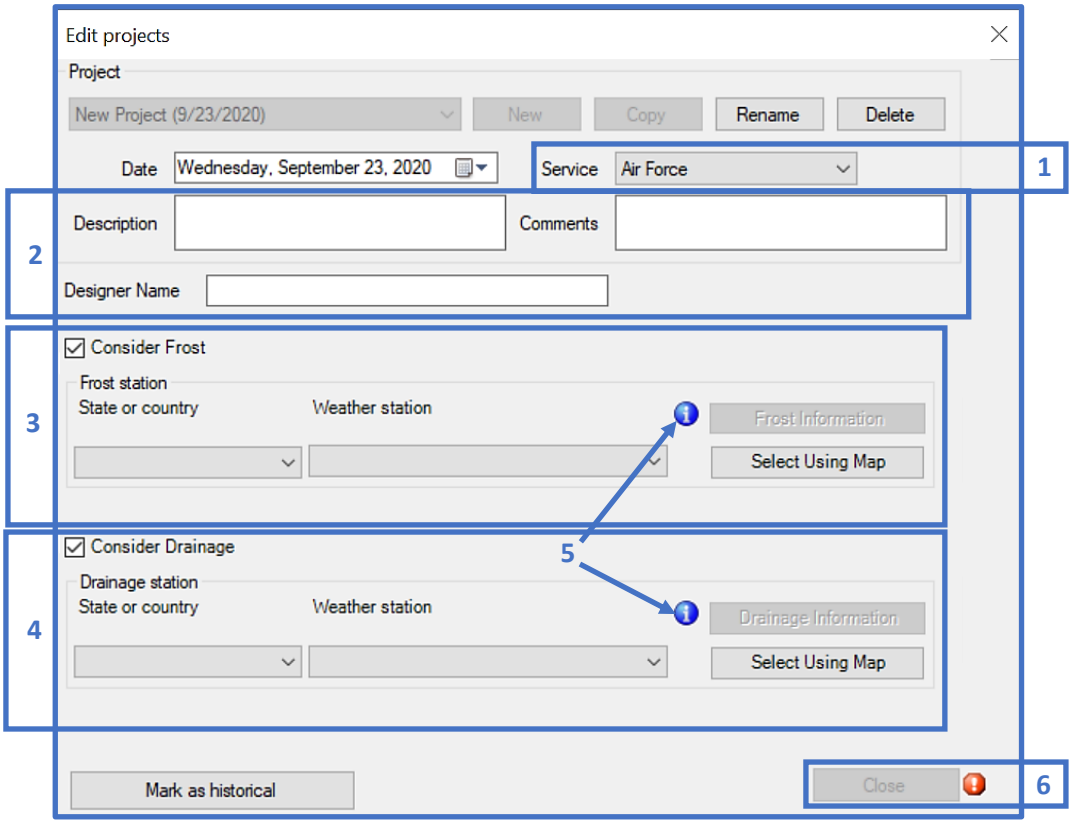


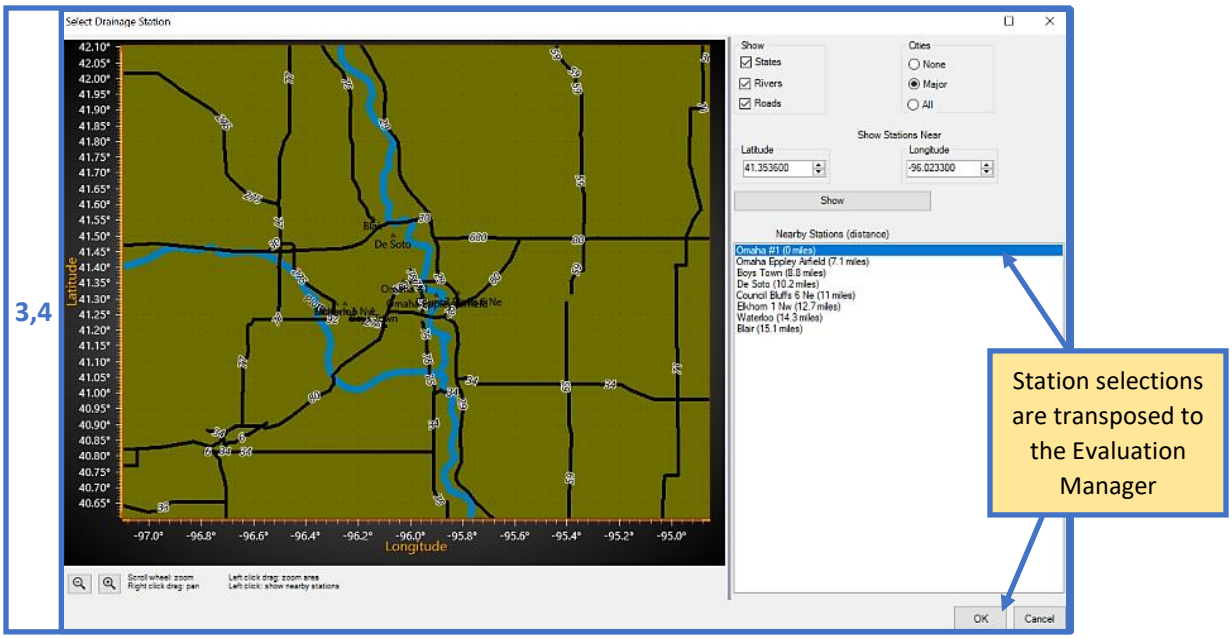
In the "Create a new project" screen, name the project, choose a date (or default to the current date), then select Ok.



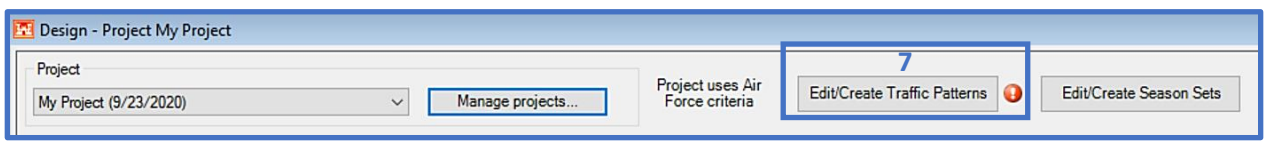
In the “Edit projects” screen:

1. Choose the Service from the pull down that is appropriate for the design project.
2. The next three fields are optional. Add a Description, Comments, and/or Designer Name, if so desired.
3. Select the Consider Frost checkbox, if applicable. Choose the State or Country and Weather station you would like to pull frost data from for the design. Click on Select Using Map to search for and select a weather station. Select an area within the map to populate Nearby Stations to choose from, or input your location in the Latitude and Longitude fields. Once you’ve selected a station, click on OK to transpose the station to Evaluation Manager.
4. Select the Consider Drainage checkbox, if applicable. The State or Country will transpose from the Consider Frost grouping. Choose the Weather station you wish to pull precipitation data from for the design. Click on Select Using Map to search for and select a Drainage station. Select an area within the map to populate Nearby Stations to choose from, or input your location in the Latitude and Longitude fields. Once you’ve selected a station, click on OK to transpose the station to Evaluation Manager.
5. View the drainage and/or frost data by clicking on the Drainage Information or Frost Information buttons, or by hovering over the blue info icons .
6. Select Close to return to the “Design Project” screen. *Note: If required information is missing the Close button will be greyed out and an error marker icon will display. Hover over the error marker icon to view the tool tip that shows the missing information.*

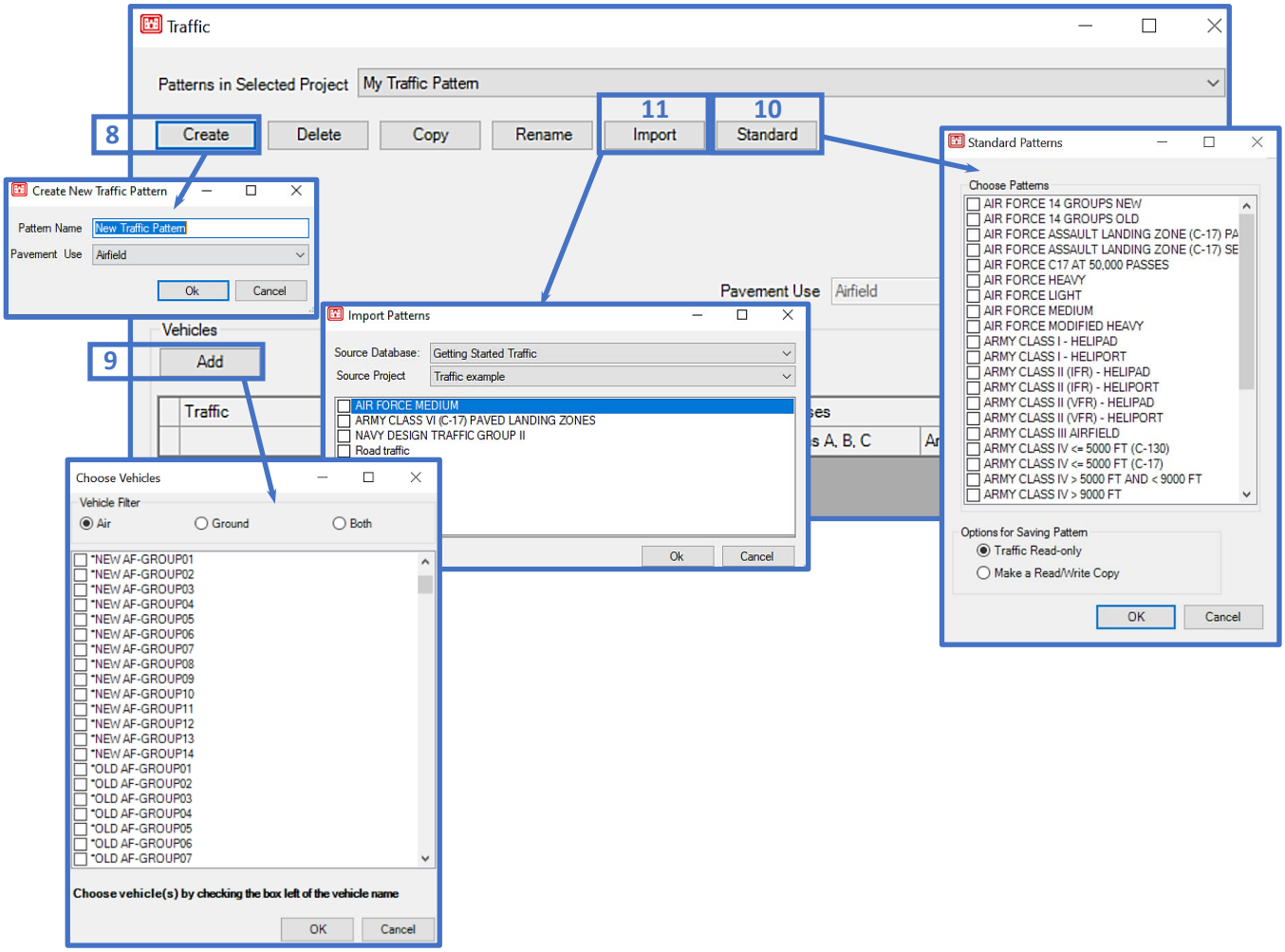




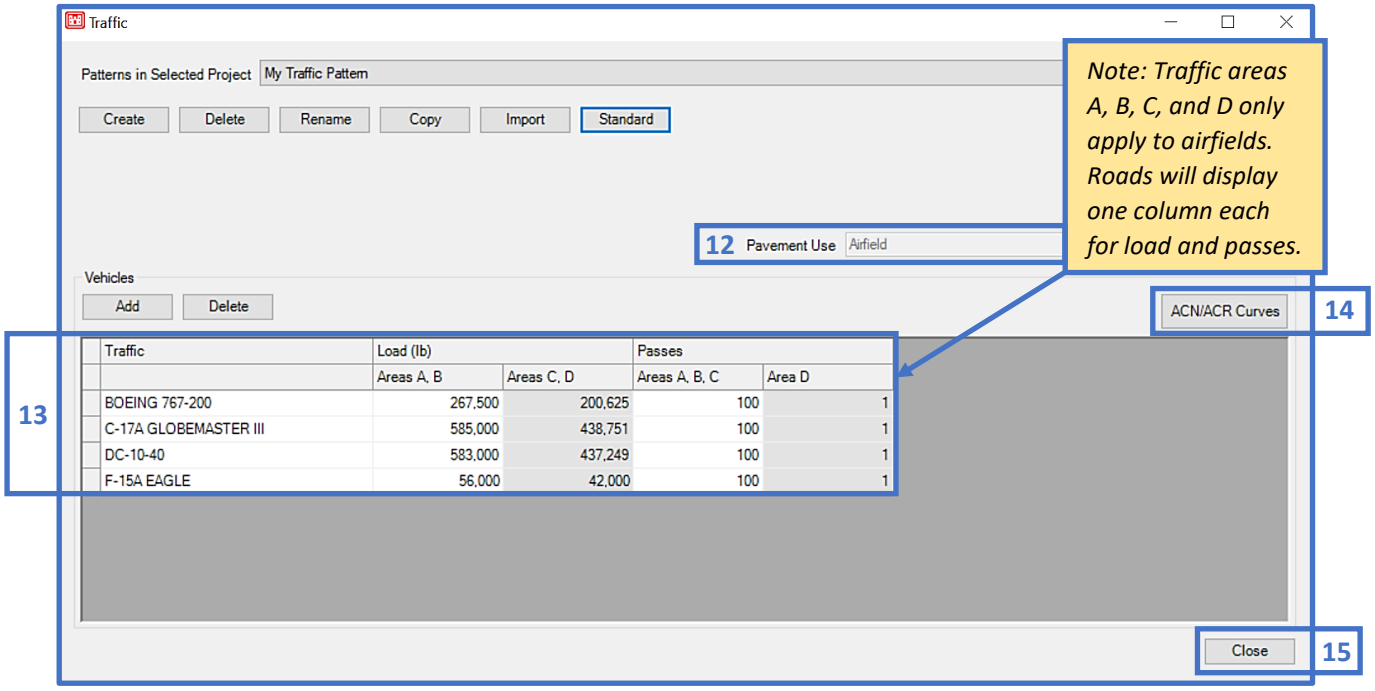
7. Click on the Edit/Create Traffic Patterns button to define traffic for the project.



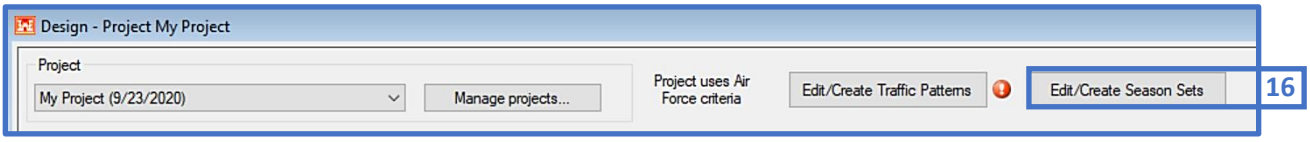
8. To define a new traffic pattern with specific vehicles, select Create. Enter a Pattern Name, select a Pavement Use, and then click Ok.
9. Click Add to select vehicles from the Choose Vehicles form. An Air, Ground, or Both vehicle filter is available. Click the box left of the vehicle name or on the vehicle name to select it. Click Add to assign the selected vehicles to the pattern.
10. Choose Standard to select from Tri-Service, pre-defined traffic patterns. Click the box left of the standard pattern name or on the name to select it. At the bottom of the form is the option to save the pattern as “Traffic Read-only” (default) or “Make a Read/Write Copy”. Click OK to assign the selected pattern.
11. Choose Import to select an existing traffic pattern from same or different source database and project.


Traffic
Patterns in Selected Project
My Traffic Pattern
8
Create
Delete
Copy
Rename
11
Import
10
Standard
Create New Traffic Pattern
Pattern Name
New Traffic Pattern
Pavement Use
Airfield
Ok
Cancel
Pavement Use
Airfield
Vehicles
9
Add
Traffic
Import Patterns
Source Database:
Getting Started Traffic
Source Project
Traffic example
AIR FORCE MEDIUM
ARMY CLASS VI (C-17) PAVED LANDING ZONES
NAVY DESIGN TRAFFIC GROUP II
Road traffic
Ok
Cancel
Standard Patterns
Choose Patterns
AIR FORCE 14 GROUPS NEW
AIR FORCE 14 GROUPS OLD
AIR FORCE ASSAULT LANDING ZONE (C-17) PA
AIR FORCE ASSAULT LANDING ZONE (C-17) SE
AIR FORCE C17 AT 50,000 PASSES
AIR FORCE HEAVY
AIR FORCE LIGHT
AIR FORCE MEDIUM
AIR FORCE MODIFIED HEAVY
ARMY CLASS I - HELIPAD
ARMY CLASS I - HELIPORT
ARMY CLASS II (IFR) - HELIPAD
ARMY CLASS II (IFR) - HELIPORT
ARMY CLASS II (VFR) - HELIPAD
ARMY CLASS II (VFR) - HELIPORT
ARMY CLASS III AIRFIELD
ARMY CLASS IV <= 5000 FT (C-130)
ARMY CLASS IV <= 5000 FT (C-17)
ARMY CLASS IV > 5000 FT AND < 9000 FT
ARMY CLASS IV > 9000 FT
Options for Saving Pattern
Traffic Read-only
Make a Read/Write Copy
OK
Cancel
Choose Vehicles
Vehicle Filter
Air
Ground
Both
*NEW AF-GROUP01
*NEW AF-GROUP02
*NEW AF-GROUP03
*NEW AF-GROUP04
*NEW AF-GROUP05
*NEW AF-GROUP06
*NEW AF-GROUP07
*NEW AF-GROUP08
*NEW AF-GROUP09
*NEW AF-GROUP10
*NEW AF-GROUP11
*NEW AF-GROUP12
*NEW AF-GROUP13
*NEW AF-GROUP14
*OLD AF-GROUP01
*OLD AF-GROUP02
*OLD AF-GROUP03
*OLD AF-GROUP04
*OLD AF-GROUP05
*OLD AF-GROUP06
*OLD AF-GROUP07
Choose vehicle(s) by checking the box left of the vehicle name
OK
Cancel

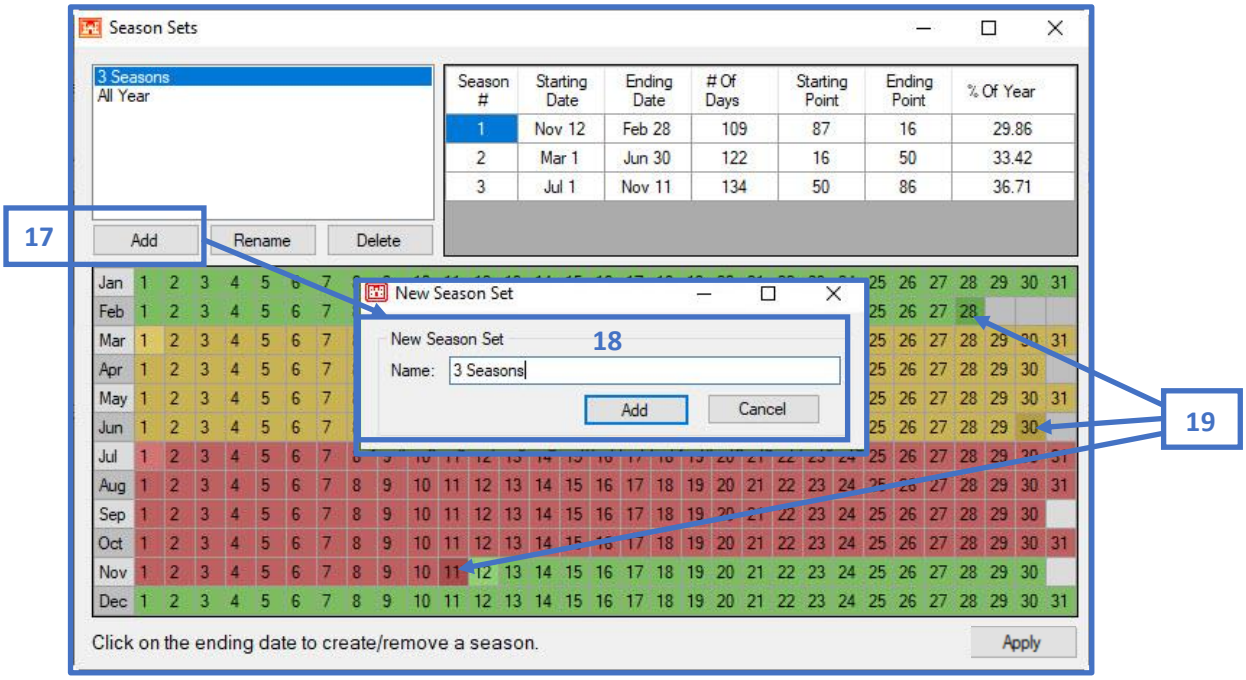
12. The Pavement Use, related to the pattern is displayed.
13. Values for Load and Passes can be edited within the grid cells.
14. Select ACN/ACR Curves to view the Aircraft Classification Number (ACN) and Aircraft Classification Rating (ACR) curves.
15. Select Close to exit Traffic and return to the Design form.



16. Select Edit/Create Season Sets to build a custom season set (*Layered Elastic Design (LED) only*). Modulus values will be assigned for each season in the layer model properties. LED defaults to one season, created season sets can be selected from the Season Set column cell drop-lists.

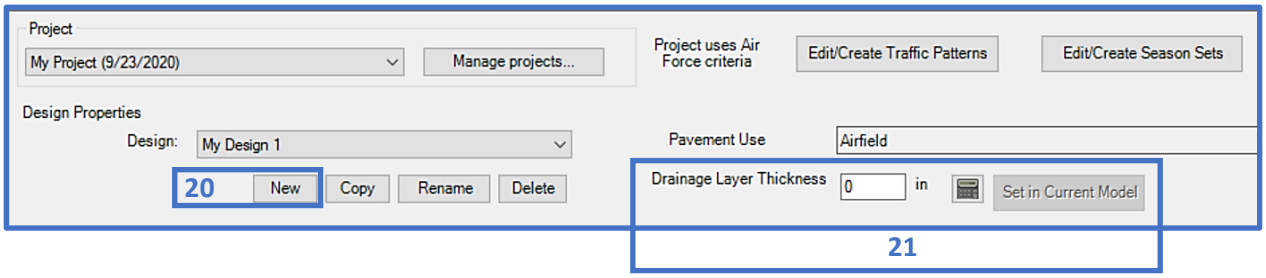


17. Select Add within the Season Sets form to begin.
18. Enter a season set Name and click Add.
19. Select the end date for each season, then select Apply.

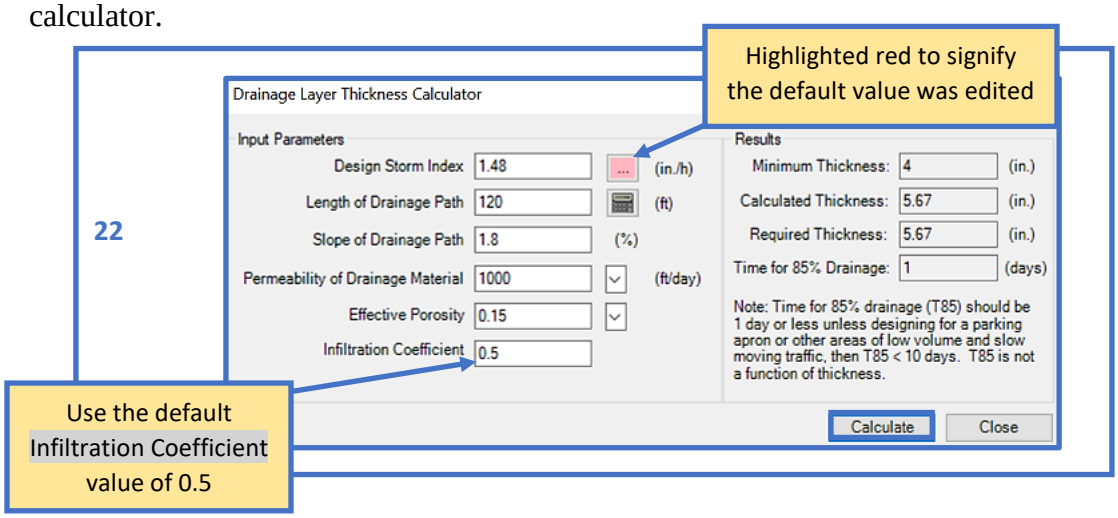


11.3 Design Properties

20. Select New to add a Design Name and choose the Pavement Use (Airfield or Roadway/Parking) for the design.
21. If you opted to Consider Drainage in Manage projects, the Drainage Layer Thickness field and calculator will be enabled. Enter a value in the Drainage Layer Thickness field or use the calculator to determine a calculated value. If a calculated Drainage layer thickness changes in subsequent layer models, click the Set in Current Model button to update the layer grid. Proceed to Step 15 if you choose not to consider drainage.



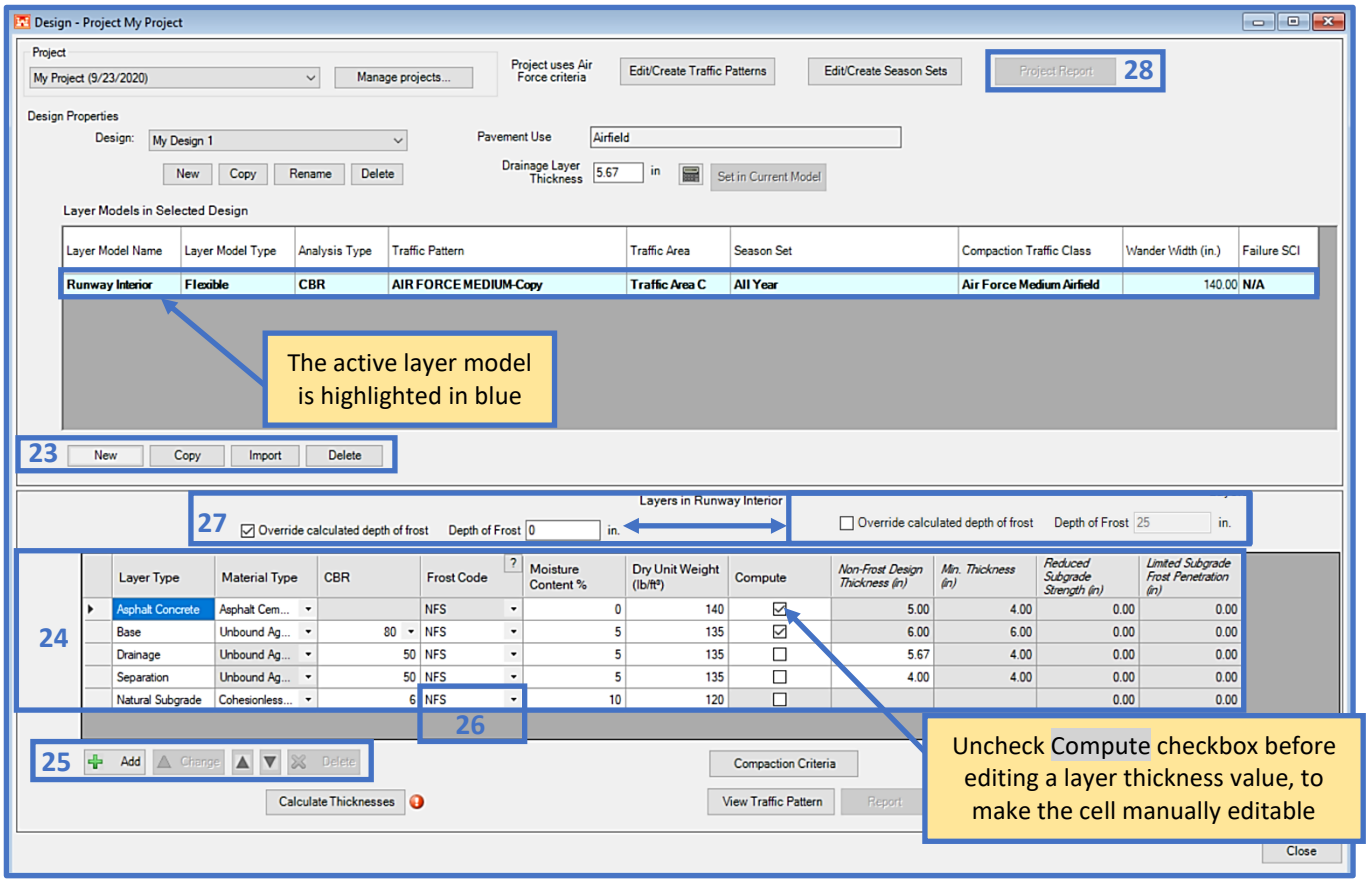
22. To use the Drainage Layer Thickness Calculator, click on the icon. The Design Storm Index value will be pulled in from the Weather station selected in Manage projects; the value may be edited. Select the calculator icon to the right of the Length of Drainage Path field to open the Drainage Path Calculator. Input values for Length of Transverse Slope, Transverse Slope, and Longitudinal Slope, then click on Calculate and the window will close and transpose the Length of Drainage Path and the Slope of the Drainage Path to the Drainage Layer Thickness Calculator window. Select a value from the drop-down field for Permeability of Drainage Material or input a value, then edit the Effective Porosity by using the drop-down options or by inputting a value. Click on the Calculate button to display results then Close the form. The calculated thickness will transpose to the Drainage Layer Thickness field in the Design Properties section upon closing the calculator.



11.4 Layer Properties

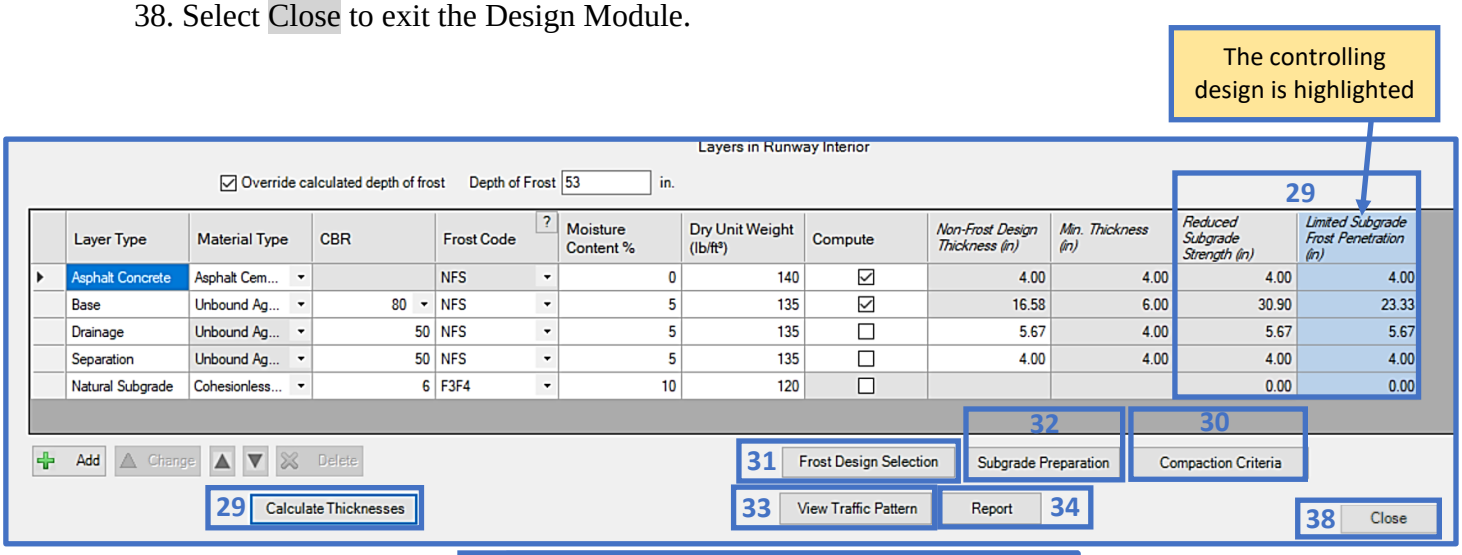
23. Select New, enter the Layer Model Name and choose the appropriate; Pavement Type, Analysis Type, Traffic Pattern, and Traffic Area. In Layer Manager, if Consider Drainage was checked the Use Drainage Layer box will be enabled. It may be unchecked if a drainage layer is not required for the model. Select Ok to return to the Design form. Select Copy to copy a layer model in the current design. Select Import to import a model layer from another design within the current database. Select Delete to delete a layer in the current design.
24. A layer structure will now populate within the layer grid section. Default values within the layer grid column fields are given. All fields are editable unless colored in gray, this signifies that the cell is set to read-only. *Note: If unacceptable values are entered into the layer grid, the cell will color red and an error marker icon will display, hover over the error marker icon*  *to view a tooltip which displays the acceptable value range.*

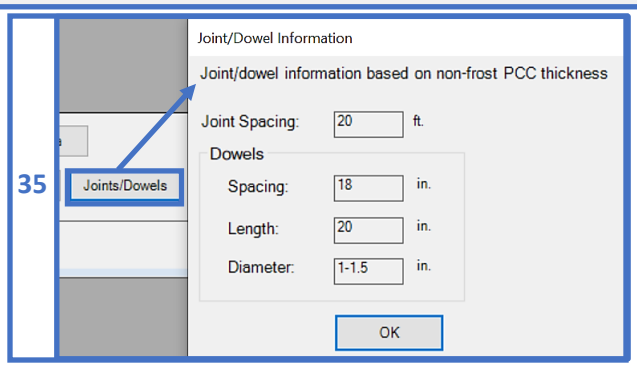
25. Layers and their coinciding material types can be added or edited using the Add or Change buttons beneath the layer grid. The Change layer button becomes enabled when the selected layer can be modified. The Delete button becomes enabled when a removable layer is selected. The Up and Down arrows enable when the selected layer can be moved.
26. Select a Frost Code for the subgrade layer from the drop-list within the NFS column cell.
27. The Override calculated depth of frost check box will be unchecked by default for newly-created layer models, which means the calculated depth of frost value will be used for the layer model. Select the check box to input your own value in the field.
28. The Project Report button launches a Microsoft® Office Excel spreadsheet of your designs across the entire selected project, each design's data is presented on a different tab within the spreadsheet. The button will enable once layer model results have been computed.



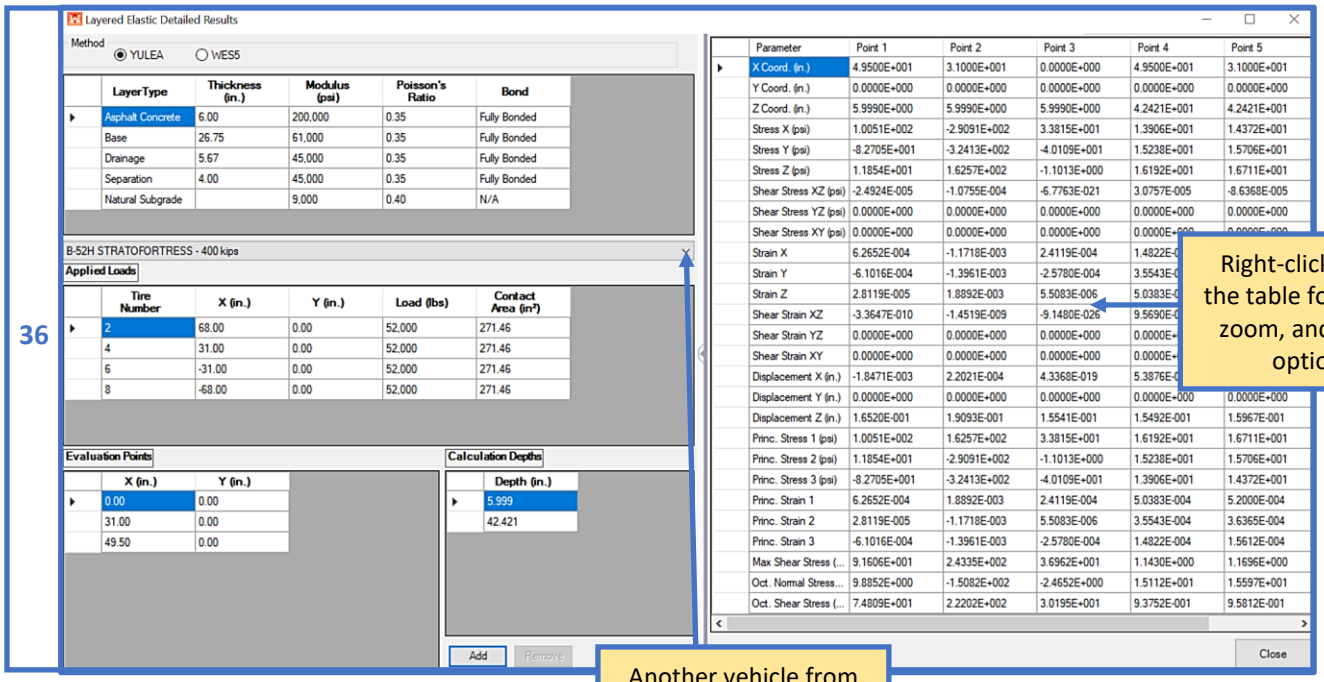
29. Once you are satisfied with all inputted and/or default values for the layer structure, click on the Calculate Thicknesses button. When frost values are used, the controlling design column will highlight in blue. *Note: When all the required fields are filled, the red icon* ❗ *will display indicating Calculate Thicknesses*.
30. Select Compaction Criteria to display subgrade compaction requirement tables.
31. Select Frost Design Selection to display the criteria and guidance for selecting the correct frost design.

32. Select Subgrade Preparation to display the calculated required depth of subgrade preparation.
33. Select View Traffic Pattern to display the Traffic assigned to the model; includes the vehicles, weights and passes. The controlling vehicle and equivalent passes are also shown, for CBR analysis type only.
34. Select Report to populate a Microsoft® Office Excel spreadsheet of your design; a summary of the data that went into the design and the results. *Note: Reports in PCASE use Excel templates or pdf report viewers without any classification markings based on the assumption that all data is unclassified and publicly releasable. If the information in the individual database is Controlled Unclassified Information (CUI), properly mark any reports generated by PCASE at the appropriate classification level; add a header and footer with the appropriate classification markings.*
35. Select Joints/Dowels to display the joint spacing and dowel requirements based on the concrete thickness. *Note: The Joints/Dowels button only appears for rigid designs.*
36. The Stresses/Strains button is enabled for LED only; when selected a form is launched that displays a table of stresses and strains data, the layer structure, and vehicle information for the selected layer model. Values can be added or removed in the Calculation Depths section.
37. The AASHTO ESALs button is only available for road designs. The form displays the selected layer structure and allows you to edit criteria and calculate estimated AASHTO ESALs.
38. Select Close to exit the Design Module.





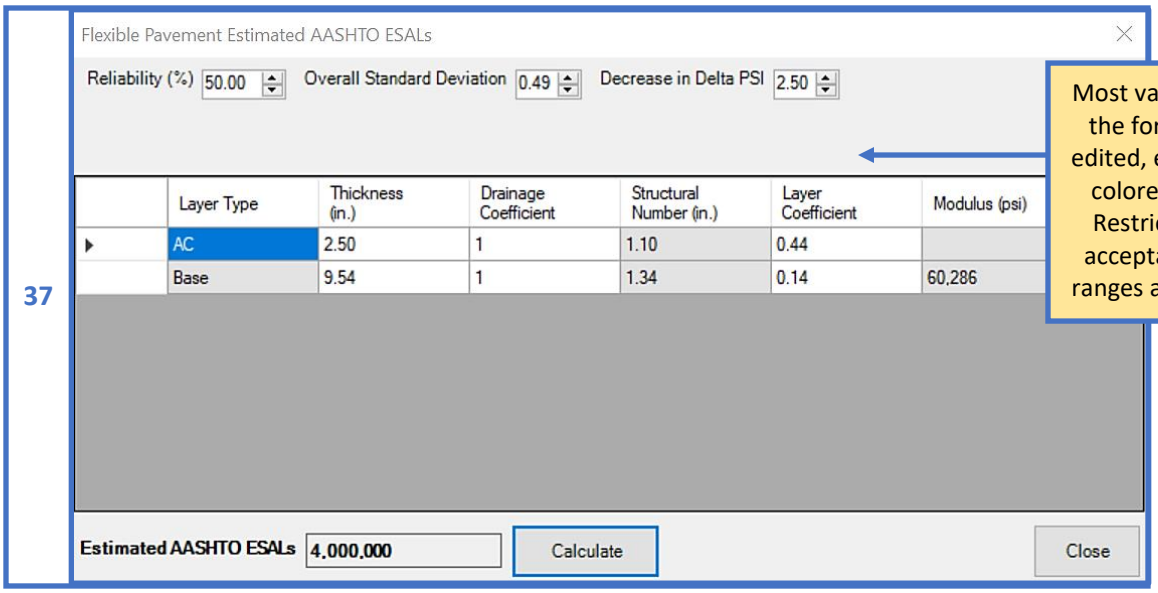
36



Right-click within the table for export, zoom, and layout options

Another vehicle from the traffic pattern can be selected from the drop-list

37



Most values within the form can be edited, except cells colored in gray. Restrictions for acceptable value ranges are applied.

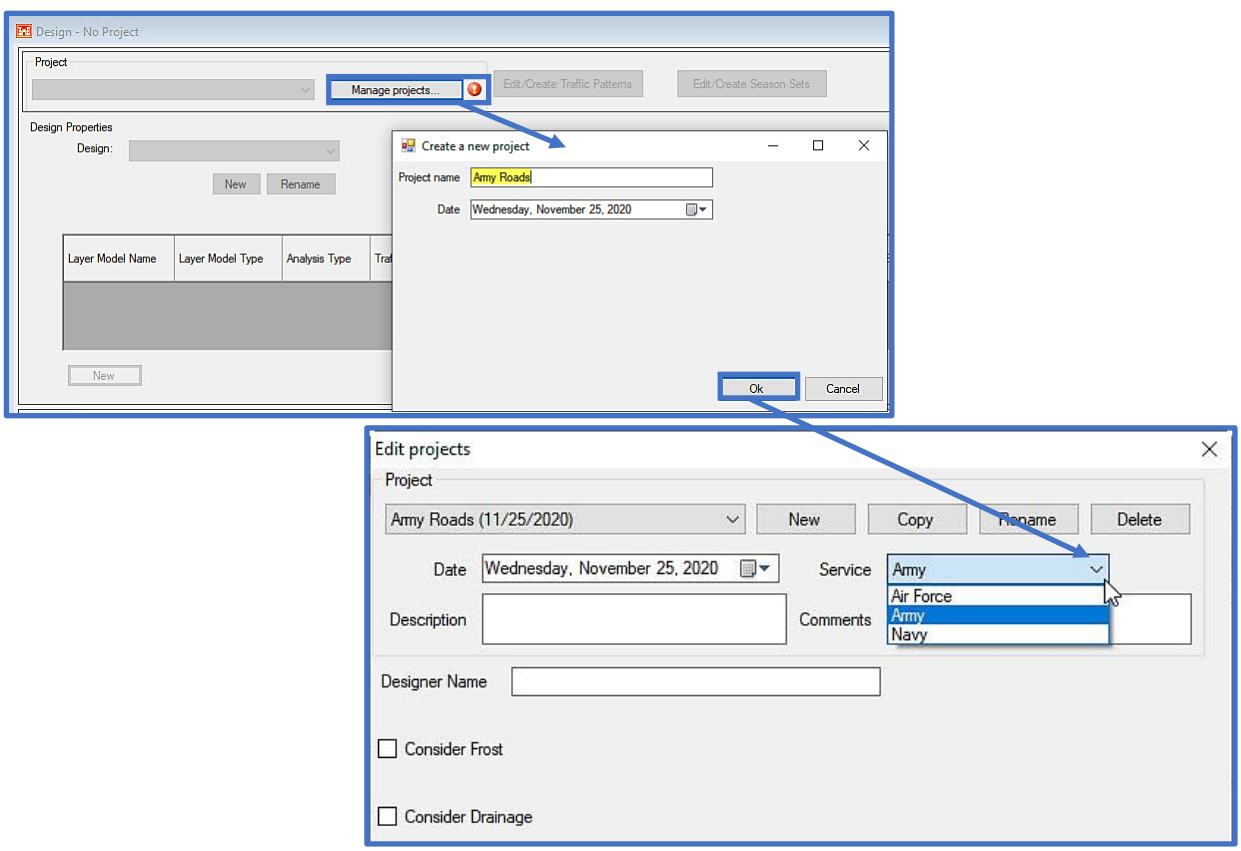
11.5 Design Examples

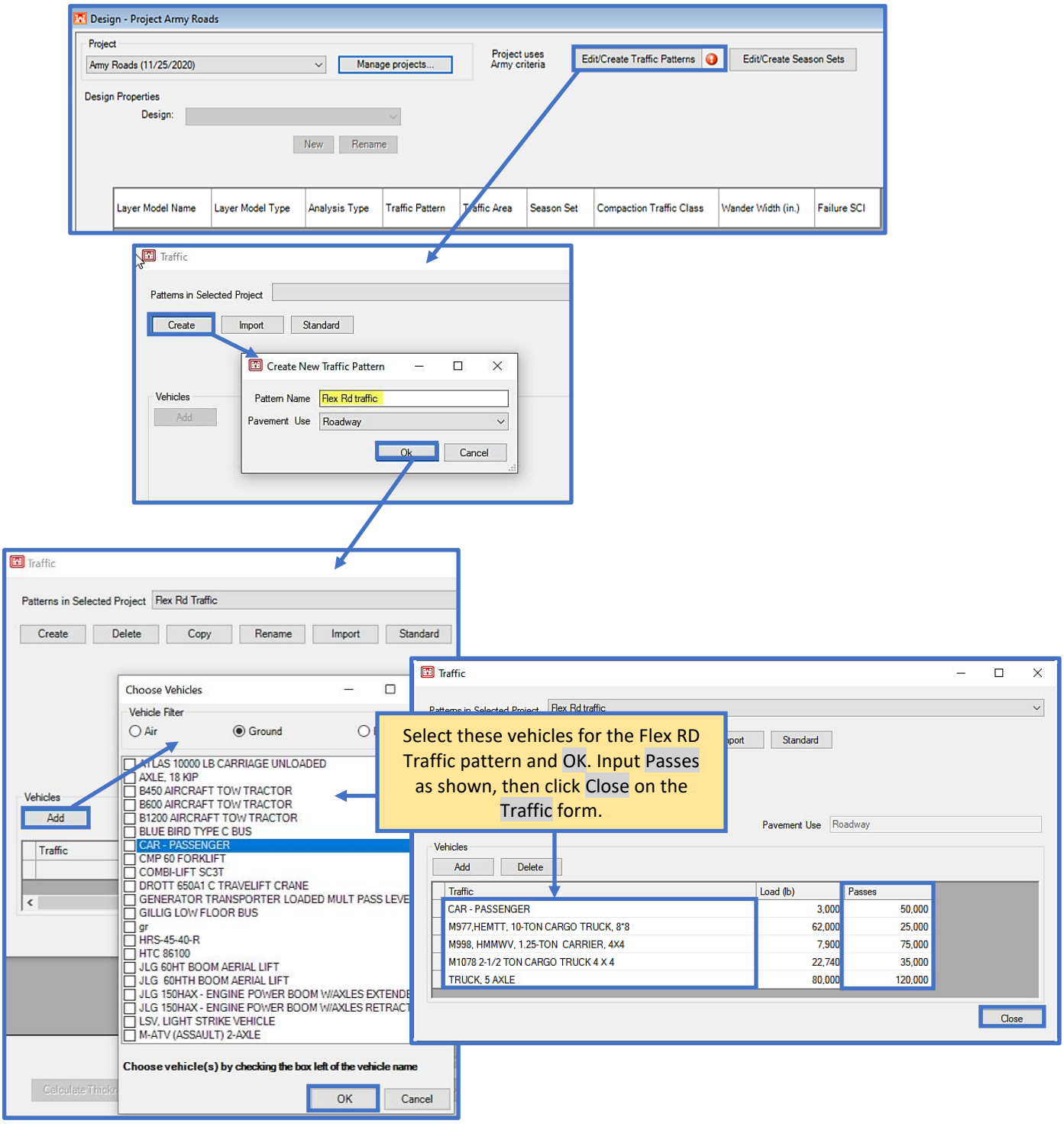
11.5.1 Flexible surfaced road using a new traffic pattern

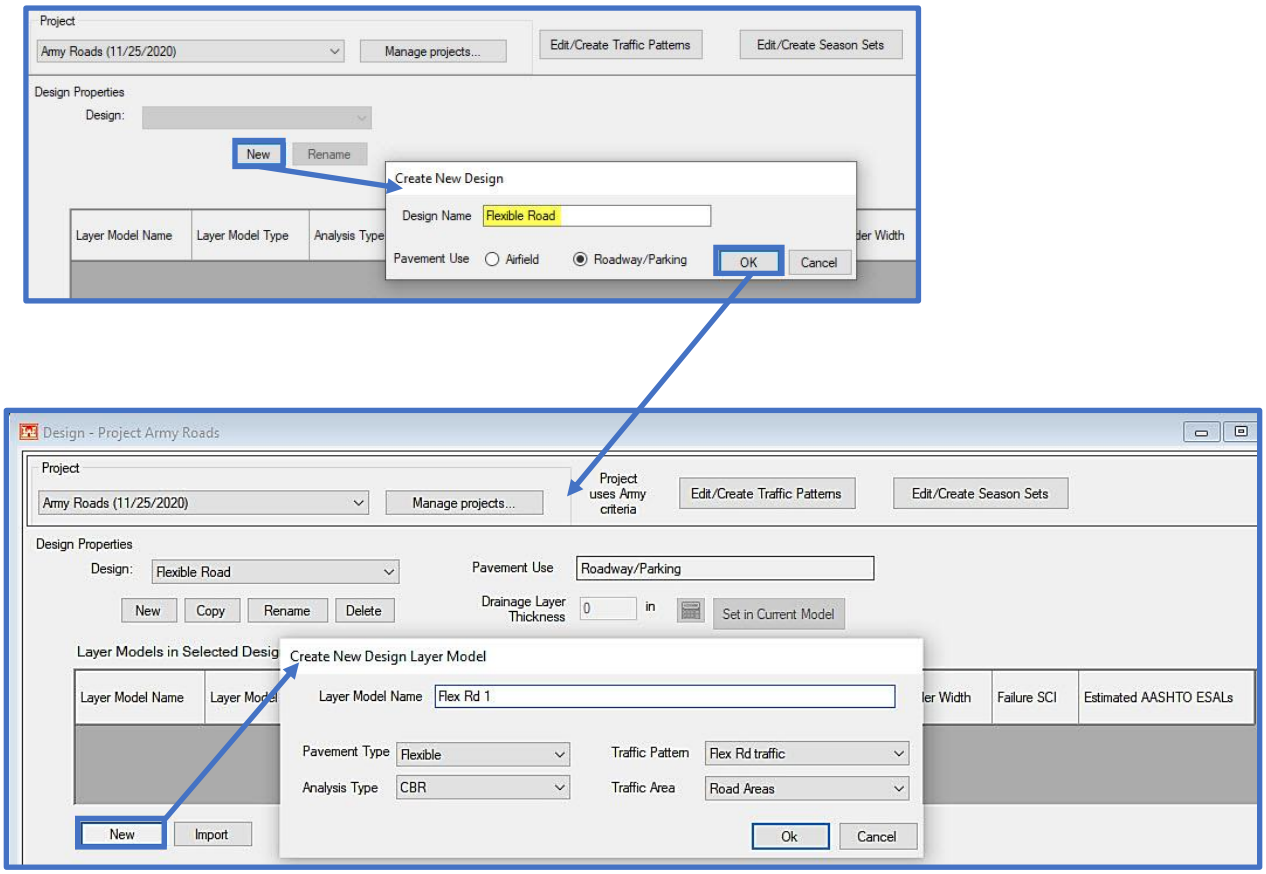
Design a flexible road at an Army installation using the vehicles, weights and passes in Table 1 and material information in Table 2.

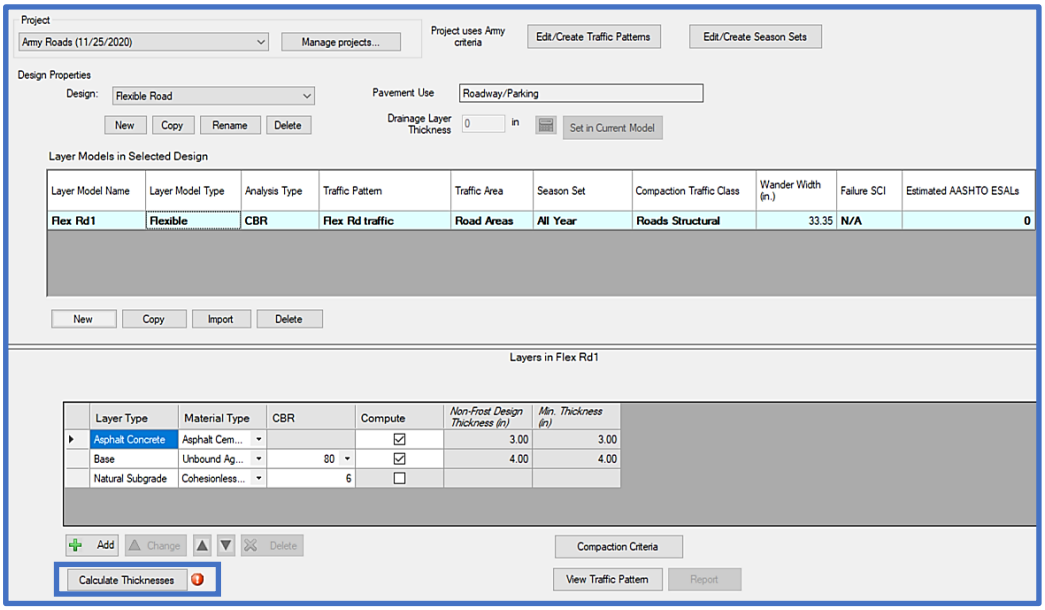
Table 1		
Ground Vehicle	**Weight (lb)**	**Passes**
Car – passenger	3,000	50,000
M977 HEMTT 10-Ton Cargo Truck 8x8	62,000	25,000
M998 HMMWV 1.25-Ton Carrier 4x4	7,900	75,000
M1078 2-1/2 Ton Cargo Truck 4x4	22,740	35,000
Truck 5 Axle	80,000	120,000

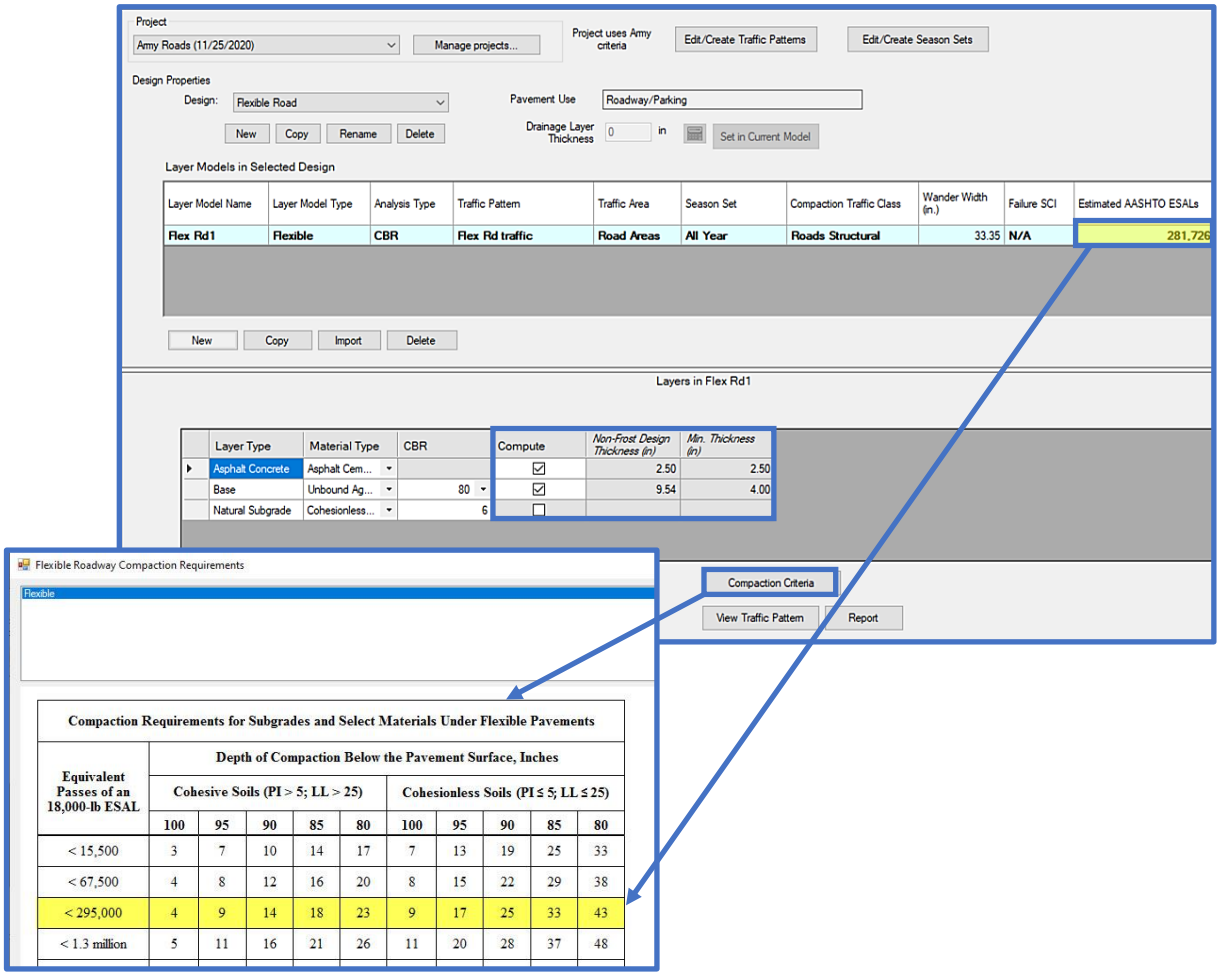
Table 2		
Layer	**Description**	**Design CBR**
Wearing surface	Asphalt Concrete (AC)	--
Base Course	GP (unbound aggregate)	80
Natural Subgrade	CH (cohesive cut)	6




Design - Project Army Roads
Project
Army Roads (11/25/2020)
Manage projects...
Project uses Army criteria
Edit/Create Traffic Patterns
Edit/Create Season Sets
Design Properties
Design:
New
Rename
Layer Model Name
Layer Model Type
Analysis Type
Traffic Pattern
Traffic Area
Season Set
Compaction Traffic Class
Wander Width (in.)
Failure SCI
Traffic
Patterns in Selected Project
Create
Import
Standard
Create New Traffic Pattern
Pattern Name
Flex Rd traffic
Pavement Use
Roadway
Ok
Cancel
Vehicles
Add
Patterns in Selected Project
Flex Rd Traffic
Delete
Copy
Rename
Choose Vehicles
Vehicle Filter
Air
Ground
ATLAS 10000 LB CARRIAGE UNLOADED
AXLE, 18 KIP
B450 AIRCRAFT TOW TRACTOR
B600 AIRCRAFT TOW TRACTOR
B1200 AIRCRAFT TOW TRACTOR
BLUE BIRD TYPE C BUS
CAR - PASSENGER
CMP 60 FORKLIFT
COMBI-LIFT SC3T
DROTT 650A1 C TRAVELIFT CRANE
GENERATOR TRANSPORTER LOADED MULT PASS LEVE
GILLIG LOW FLOOR BUS
gr
HRS-45-40-R
HTC 86100
JLG 60HT BOOM AERIAL LIFT
JLG 60HTH BOOM AERIAL LIFT
JLG 150HAX - ENGINE POWER BOOM W/AXLES EXTENDE
JLG 150HAX - ENGINE POWER BOOM W/AXLES RETRACT
LSV, LIGHT STRIKE VEHICLE
M-ATV (ASSAULT) 2-AXLE
Choose vehicle(s) by checking the box left of the vehicle name
OK
Cancel
Select these vehicles for the Flex RD Traffic pattern and OK. Input Passes as shown, then click Close on the Traffic form.
Flex Rd traffic
Pavement Use
Roadway
Vehicles
Add
Delete
Traffic
Load (lb)
Passes
CAR - PASSENGER 3,000 50,000
M977,HEMTT, 10-TON CARGO TRUCK, 8*8 62,000 25,000
M998, HMMWV, 1.25-TON CARRIER, 4X4 7,900 75,000
M1078 2-1/2 TON CARGO TRUCK 4 X 4 22,740 35,000
TRUCK, 5 AXLE 80,000 120,000
Close


Project
Army Roads (11/25/2020)
Manage projects...
Edit/Create Traffic Patterns
Edit/Create Season Sets
Design Properties
Design:
New
Rename
Create New Design
Design Name
Flexible Road
Pavement Use
Airfield
Roadway/Parking
OK
Cancel
Layer Model Name
Layer Model Type
Analysis Type
Design - Project Army Roads
Project
Army Roads (11/25/2020)
Manage projects...
Project uses Army criteria
Edit/Create Traffic Patterns
Edit/Create Season Sets
Design Properties
Design:
Flexible Road
Pavement Use
Roadway/Parking
New
Copy
Rename
Delete
Drainage Layer Thickness
0
in
Set in Current Model
Layer Models in Selected Desig
Create New Design Layer Model
Layer Model Name
Flex Rd 1
Pavement Type
Flexible
Traffic Pattern
Flex Rd traffic
Analysis Type
CBR
Traffic Area
Road Areas
Ok
Cancel
Layer Model Name
Failure SCI
Estimated AASHTO ESALs
New
Import



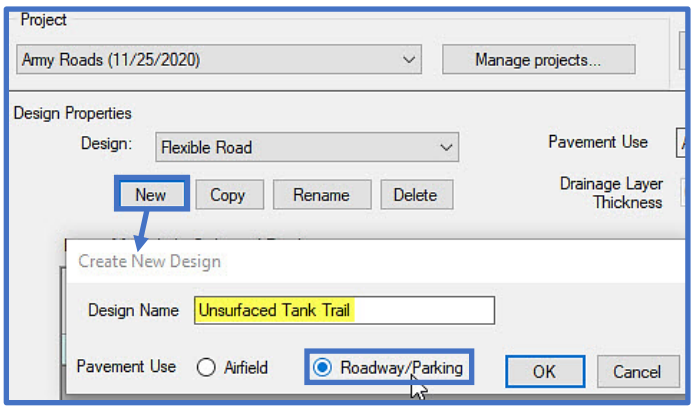


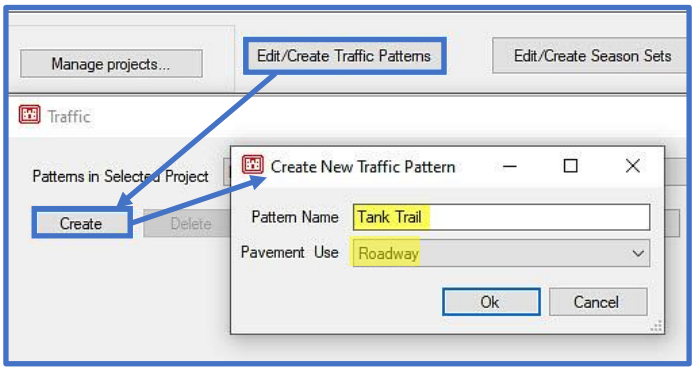
Compaction Requirements for Subgrades and Select Materials Under Flexible Pavements

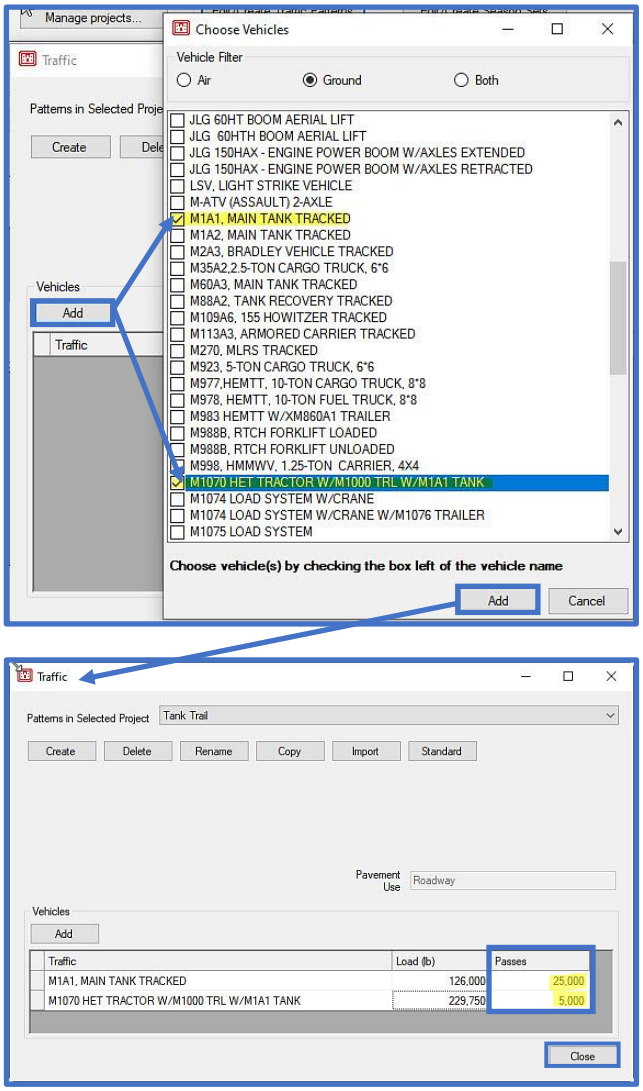
Equivalent Passes of an 18,000-lb ESAL	Depth of Compaction Below the Pavement Surface, Inches									
	Cohesive Soils (PI > 5; LL > 25)					Cohesionless Soils (PI ≤ 5; LL ≤ 25)				
	100	95	90	85	80	100	95	90	85	80
< 15,500	3	7	10	14	17	7	13	19	25	33
< 67,500	4	8	12	16	20	8	15	22	29	38
< 295,000	4	9	14	18	23	9	17	25	33	43
< 1.3 million	5	11	16	21	26	11	20	28	37	48

11.5.2 Unsurfaced tank trail using a new traffic pattern

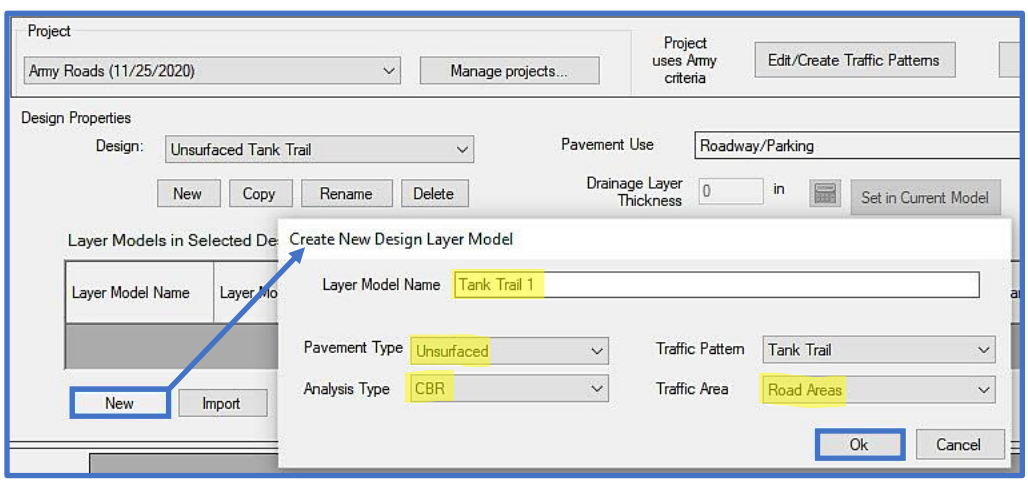
Design a CBR single layer aggregate surfaced (unsurfaced) tank trail for a 5-year life given 5,000 annual passes of the M1A1 and 1,000 annual passes of the M1070 Het Tractor W/M10000 TRL W/M1A1 (both at default weights). Use 80 CBR for the aggregate surface layer and 8 CBR for the subgrade.

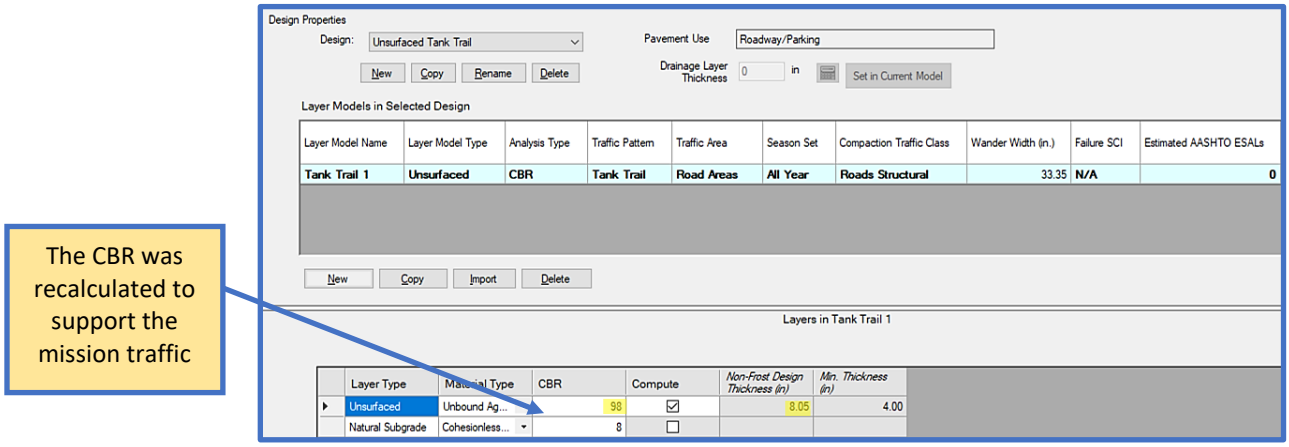





Manage projects...
Traffic
Patterns in Selected Proje
Create
Dele
Vehicles
Add
Traffic
Choose Vehicles
Vehicle Filter
Air
Ground
Both
JLG 60HT BOOM AERIAL LIFT
JLG 60HTH BOOM AERIAL LIFT
JLG 150HAX - ENGINE POWER BOOM W/AXLES EXTENDED
JLG 150HAX - ENGINE POWER BOOM W/AXLES RETRACTED
LSV, LIGHT STRIKE VEHICLE
M-ATV (ASSAULT) 2-AXLE
M1A1, MAIN TANK TRACKED
M1A2, MAIN TANK TRACKED
M2A3, BRADLEY VEHICLE TRACKED
M35A2,2.5-TON CARGO TRUCK, 6*6
M60A3, MAIN TANK TRACKED
M88A2, TANK RECOVERY TRACKED
M109A6, 155 HOWITZER TRACKED
M113A3, ARMORED CARRIER TRACKED
M270, MLRS TRACKED
M923, 5-TON CARGO TRUCK, 6*6
M977,HEMTT, 10-TON CARGO TRUCK, 8*8
M978, HEMTT, 10-TON FUEL TRUCK, 8*8
M983 HEMTT W/XM860A1 TRAILER
M988B, RTCH FORKLIFT LOADED
M988B, RTCH FORKLIFT UNLOADED
M998, HMMWV, 1.25-TON CARRIER, 4X4
M1070 HET TRACTOR W/M1000 TRL W/M1A1 TANK
M1074 LOAD SYSTEM W/CRANE
M1074 LOAD SYSTEM W/CRANE W/M1076 TRAILER
M1075 LOAD SYSTEM
Choose vehicle(s) by checking the box left of the vehicle name
Add
Cancel

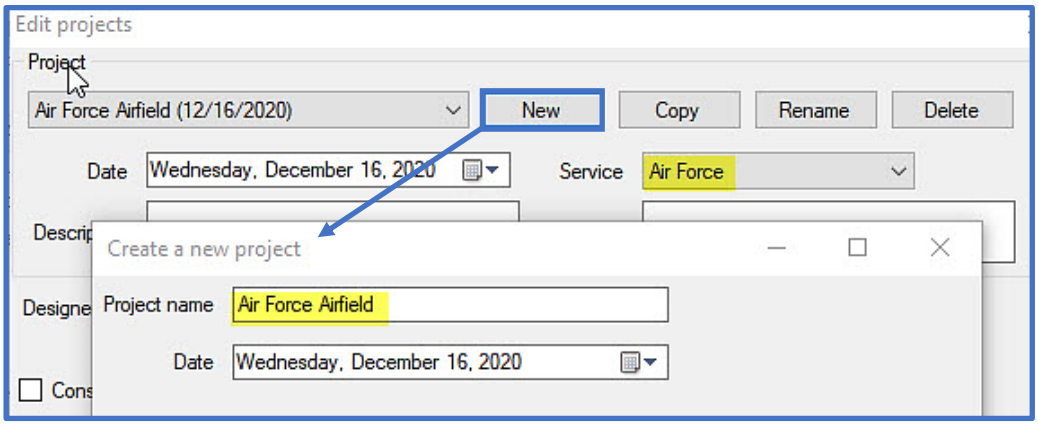
Traffic
Patterns in Selected Project
Tank Trail
Create
Delete
Rename
Copy
Import
Standard
Pavement Use
Roadway
Vehicles
Add
Traffic
Load (lb)
Passes
M1A1, MAIN TANK TRACKED
126,000
25,000
M1070 HET TRACTOR W/M1000 TRL W/M1A1 TANK
229,750
5,000
Close

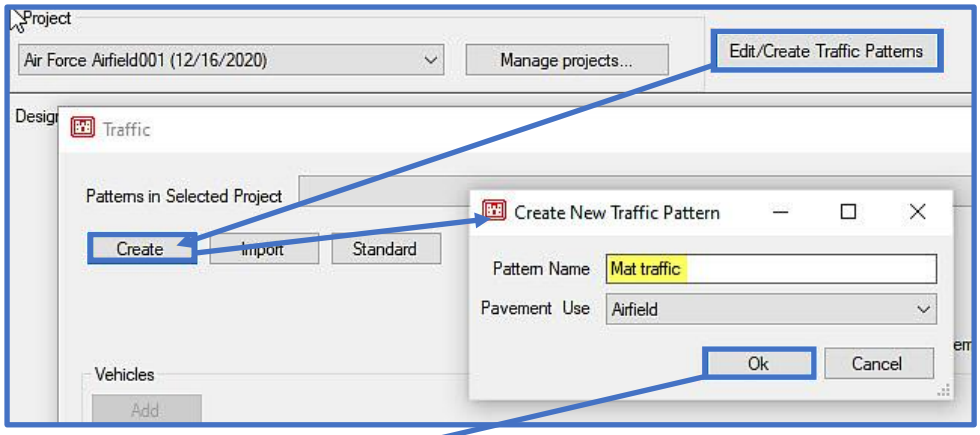

Project
Army Roads (11/25/2020)
Manage projects...
Project uses Army criteria
Edit/Create Traffic Patterns
Design Properties
Design:
Unsurfaced Tank Trail
Pavement Use
Roadway/Parking
New
Copy
Rename
Delete
Drainage Layer Thickness
0
in
Set in Current Model
Layer Models in Selected De
Layer Model Name
Layer Mo
New
Import
Create New Design Layer Model
Layer Model Name
Tank Trail 1
Pavement Type
Unsurfaced
Traffic Pattern
Tank Trail
Analysis Type
CBR
Traffic Area
Road Areas
Ok
Cancel

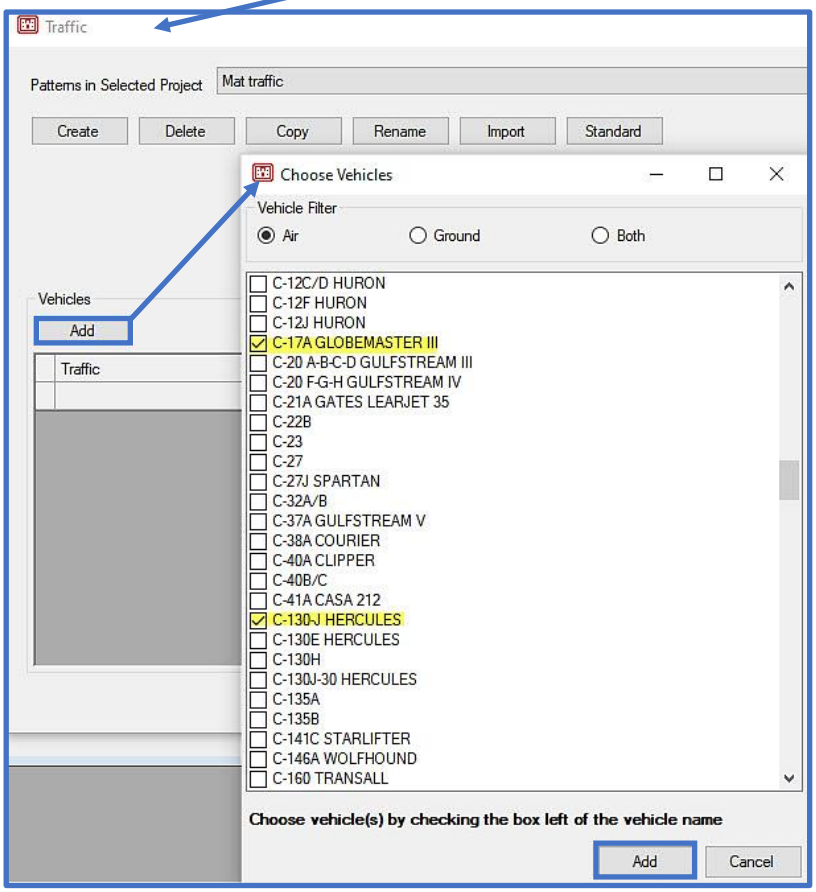


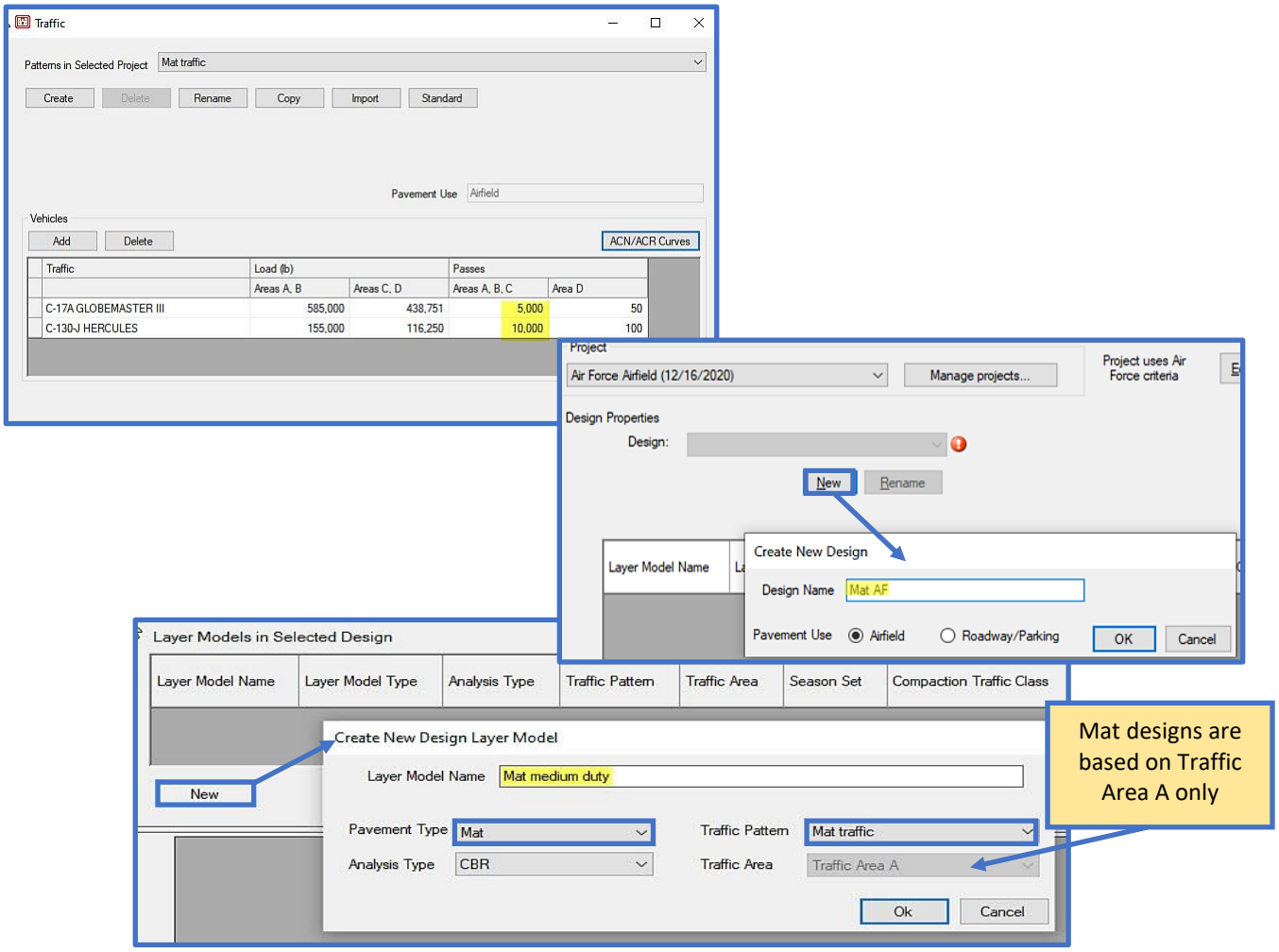
11.5.3 Mat surfaced airfield using a new traffic pattern

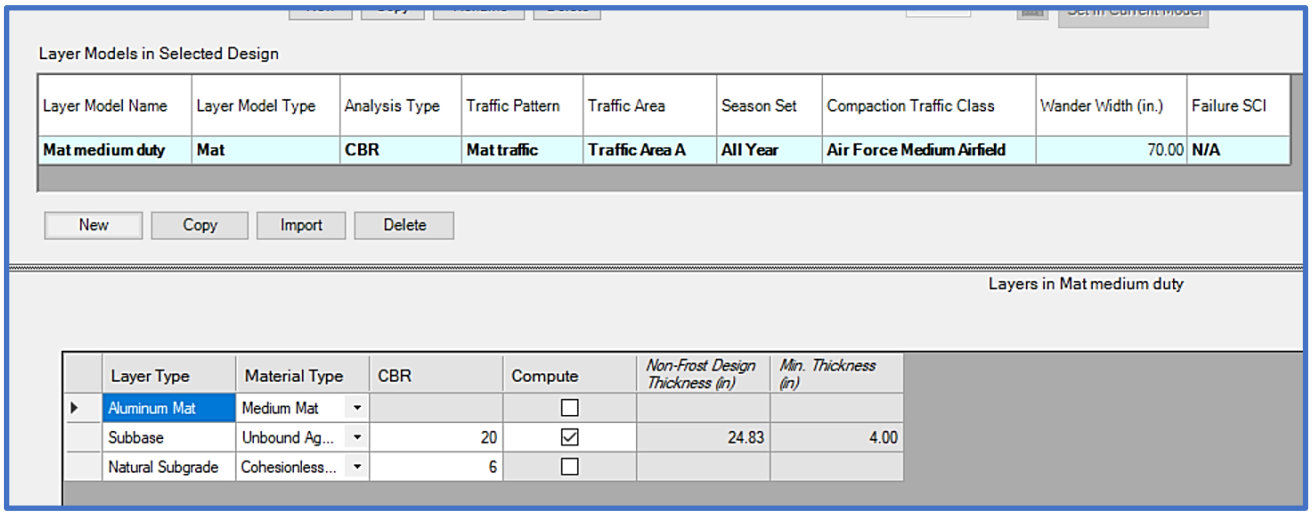
Design an AM-2 (medium duty) mat surfaced apron (traffic area A) by determining the required subbase thickness (assume 20 CBR) under the mat. The traffic includes 5,000 passes of the C-17 (585 kips) and 10,000 passes of the C-130J aircraft (155 kips). Use a natural subgrade CBR of 6.




Project
Air Force Airfield001 (12/16/2020)
Manage projects...
Edit/Create Traffic Patterns
Traffic
Patterns in Selected Project
Create
Import
Standard
Create New Traffic Pattern
Pattern Name
Mat traffic
Pavement Use
Airfield
Ok
Cancel
Vehicles
Add


Traffic
Patterns in Selected Project
Mat traffic
Create
Delete
Copy
Rename
Import
Standard
Vehicles
Add
Traffic
Choose Vehicles
Vehicle Filter
Air
Ground
Both
C-12C/D HURON
C-12F HURON
C-12J HURON
C-17A GLOBEMASTER III
C-20 A-B-C-D GULFSTREAM III
C-20 F-G-H GULFSTREAM IV
C-21A GATES LEARJET 35
C-22B
C-23
C-27
C-27J SPARTAN
C-32A/B
C-37A GULFSTREAM V
C-38A COURIER
C-40A CLIPPER
C-40B/C
C-41A CASA 212
C-130-J HERCULES
C-130E HERCULES
C-130H
C-130J-30 HERCULES
C-135A
C-135B
C-141C STARLIFTER
C-146A WOLFHOUND
C-160 TRANSALL
Choose vehicle(s) by checking the box left of the vehicle name
Add
Cancel

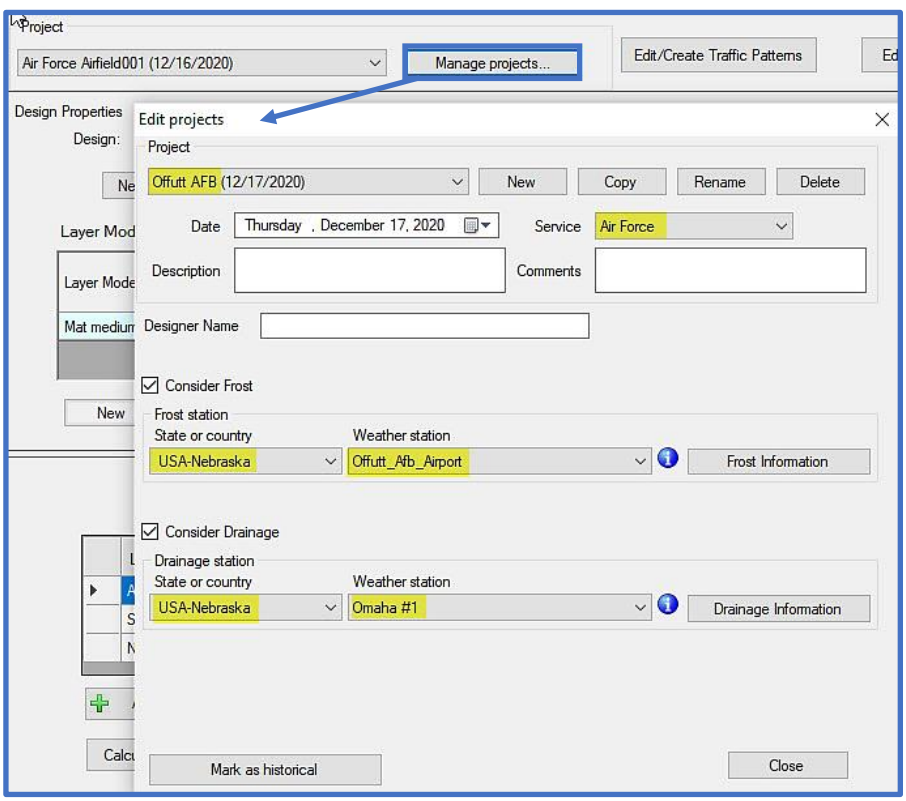

Traffic
Patterns in Selected Project
Mat traffic
Create
Delete
Rename
Copy
Import
Standard
Pavement Use
Airfield
Vehicles
Add
Delete
ACN/ACR Curves
Traffic
Load (lb)
Passes
Areas A, B
Areas C, D
Areas A, B, C
Area D
C-17A GLOBEMASTER III
585,000
438,751
5,000
50
C-130-J HERCULES
155,000
116,250
10,000
100
Project
Air Force Airfield (12/16/2020)
Manage projects...
Project uses Air Force criteria
Design Properties
Design:
New
Rename
Layer Model Name
Create New Design
Design Name
Mat AF
Pavement Use
Airfield
Roadway/Parking
OK
Cancel
Layer Models in Selected Design
Layer Model Name
Layer Model Type
Analysis Type
Traffic Pattern
Traffic Area
Season Set
Compaction Traffic Class
New
Create New Design Layer Model
Layer Model Name
Mat medium duty
Pavement Type
Mat
Traffic Pattern
Mat traffic
Analysis Type
CBR
Traffic Area
Traffic Area A
Ok
Cancel
Mat designs are based on Traffic Area A only

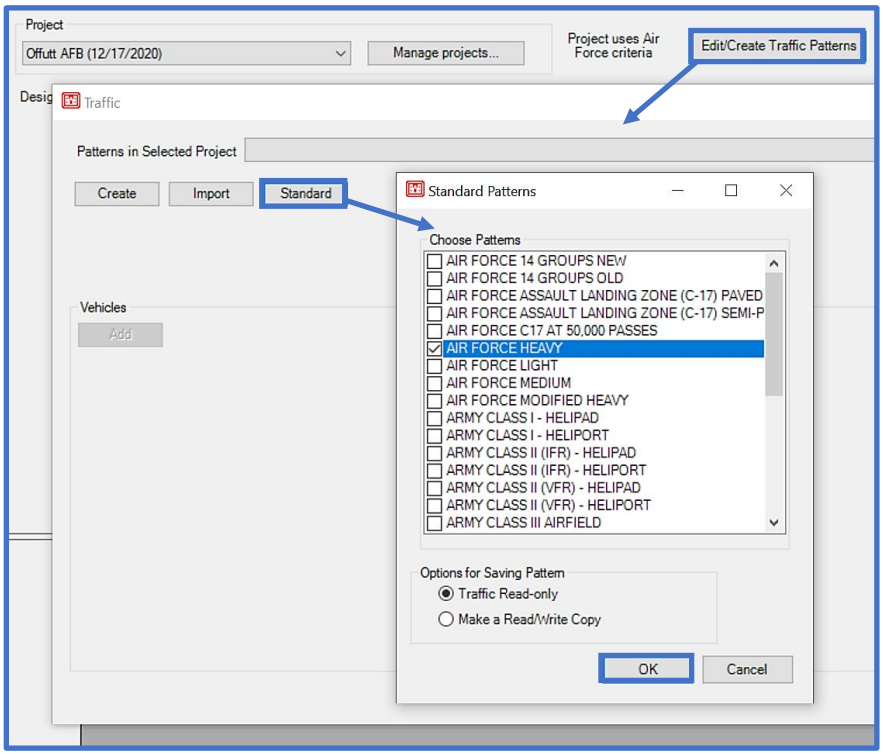

Layer Models in Selected Design
Layer Model Name
Layer Model Type
Analysis Type
Traffic Pattern
Traffic Area
Season Set
Compaction Traffic Class
Wander Width (in.)
Failure SCI
Mat medium duty
Mat
CBR
Mat traffic
Traffic Area A
All Year
Air Force Medium Airfield
70.00
N/A
New
Copy
Import
Delete
Layers in Mat medium duty
Layer Type
Material Type
CBR
Compute
Non-Frost Design Thickness (in)
Min. Thickness (in)
Aluminum Mat
Medium Mat
Subbase
Unbound Ag...
20
24.83
4.00
Natural Subgrade
Cohesionless...
6

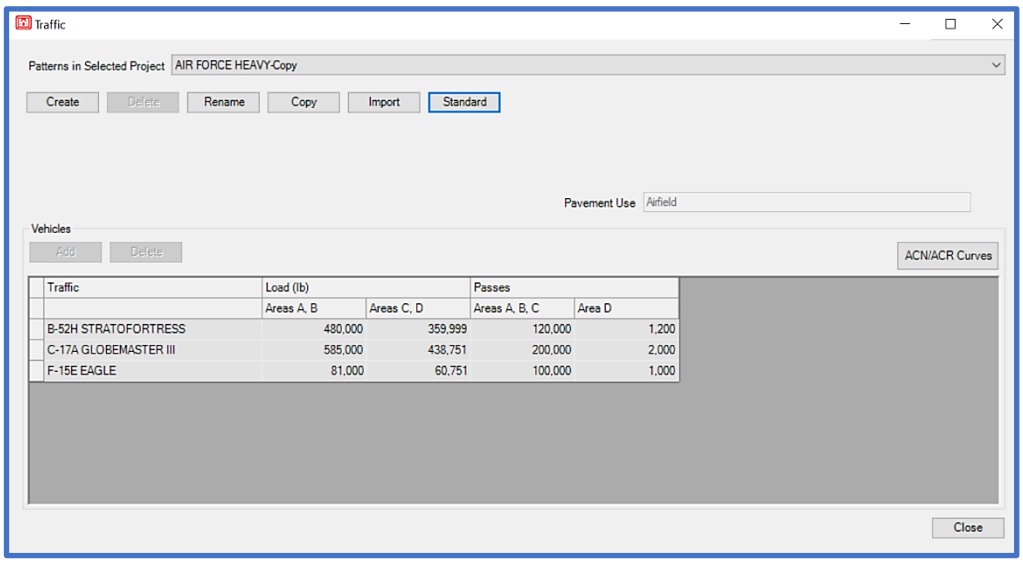
11.5.4 Flexible surfaced airfield using standard traffic in a frost area

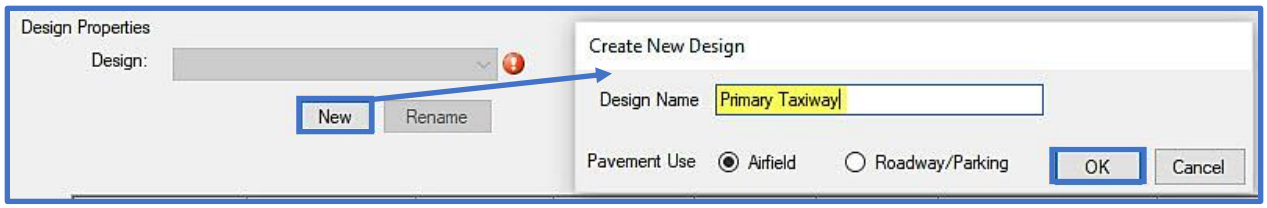
Design a new Primary Taxiway (type A traffic) at Offutt AFB (near Omaha), Nebraska for **Air Force Heavy** standard traffic and the material conditions given in the table below. Design for frost conditions. Drainage is required when designing for frost. The taxiway will be 75 feet wide and crowned in the middle, the transverse and longitudinal slopes will be 1%. The design will primarily involve subgrade cuts (for compaction requirements).

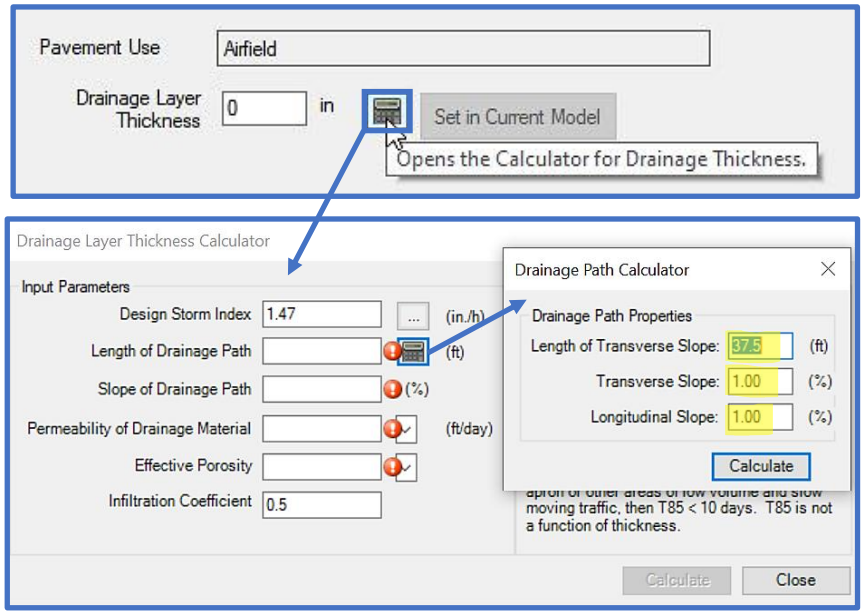
Layer	Description	Frost Code	Design CBR	Dry Unit Weight (pcf)	% Moisture
Wearing Surface	Asphalt Cement (AC)	F0	--	140	0
Base Course	Gravel (GP) Unbound aggregate	F0	80	135	5
Drainage Layer	Bank run sands Permeability = 1000 ft/day	F0	50	130	5
Separation Layer	Geotextile	--	--	--	--
Subbase Course	Gravel (GP)	F0	20	130	8
Natural Subgrade	Clay (CL), PI > 5	F3	6	100	18

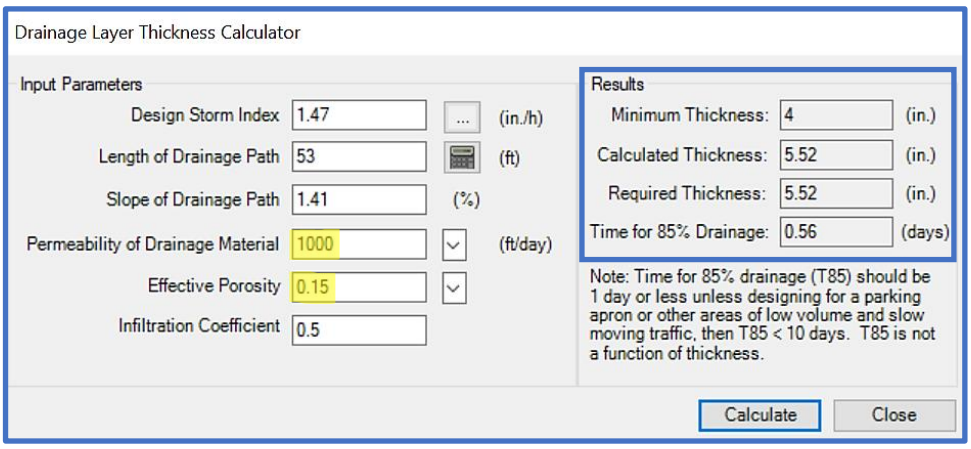


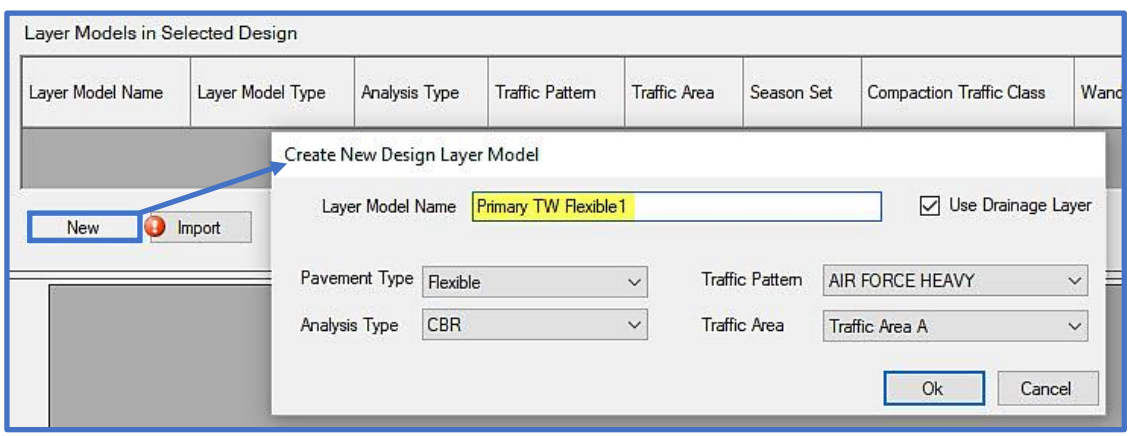

Project
Offutt AFB (12/17/2020)
Manage projects...
Project uses Air Force criteria
Edit/Create Traffic Patterns
Traffic
Patterns in Selected Project
Create
Import
Standard
Vehicles
Add
Standard Patterns
Choose Patterns
AIR FORCE 14 GROUPS NEW
AIR FORCE 14 GROUPS OLD
AIR FORCE ASSAULT LANDING ZONE (C-17) PAVED
AIR FORCE ASSAULT LANDING ZONE (C-17) SEMI-P
AIR FORCE C17 AT 50,000 PASSES
AIR FORCE HEAVY
AIR FORCE LIGHT
AIR FORCE MEDIUM
AIR FORCE MODIFIED HEAVY
ARMY CLASS I - HELIPAD
ARMY CLASS I - HELIPORT
ARMY CLASS II (IFR) - HELIPAD
ARMY CLASS II (IFR) - HELIPORT
ARMY CLASS II (VFR) - HELIPAD
ARMY CLASS II (VFR) - HELIPORT
ARMY CLASS III AIRFIELD
Options for Saving Pattern
Traffic Read-only
Make a Read/Write Copy
OK
Cancel

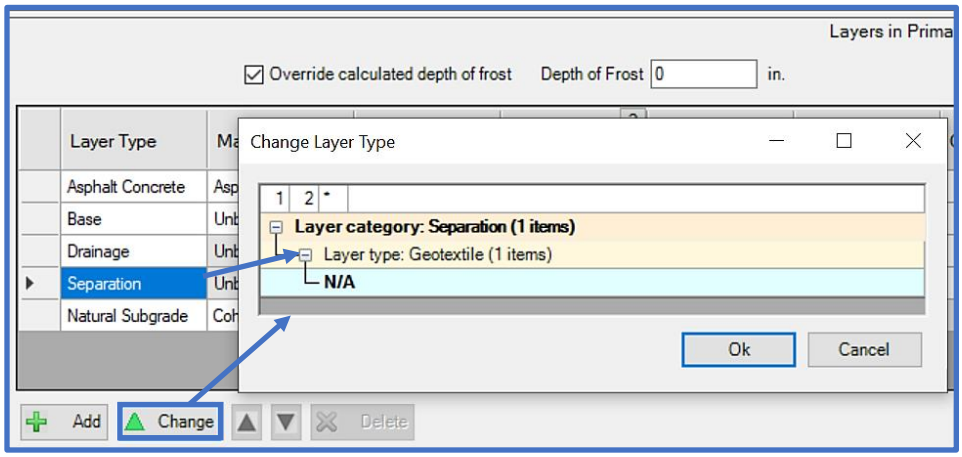

Traffic
Patterns in Selected Project
AIR FORCE HEAVY-Copy
Create
Delete
Rename
Copy
Import
Standard
Pavement Use
Airfield
Vehicles
Add
Delete
ACN/ACR Curves
Traffic
Load (lb)
Passes
Areas A, B
Areas C, D
Areas A, B, C
Area D
B-52H STRATOFORTRESS 480,000 359,999 120,000 1,200
C-17A GLOBEMASTER III 585,000 438,751 200,000 2,000
F-15E EAGLE 81,000 60,751 100,000 1,000
Close

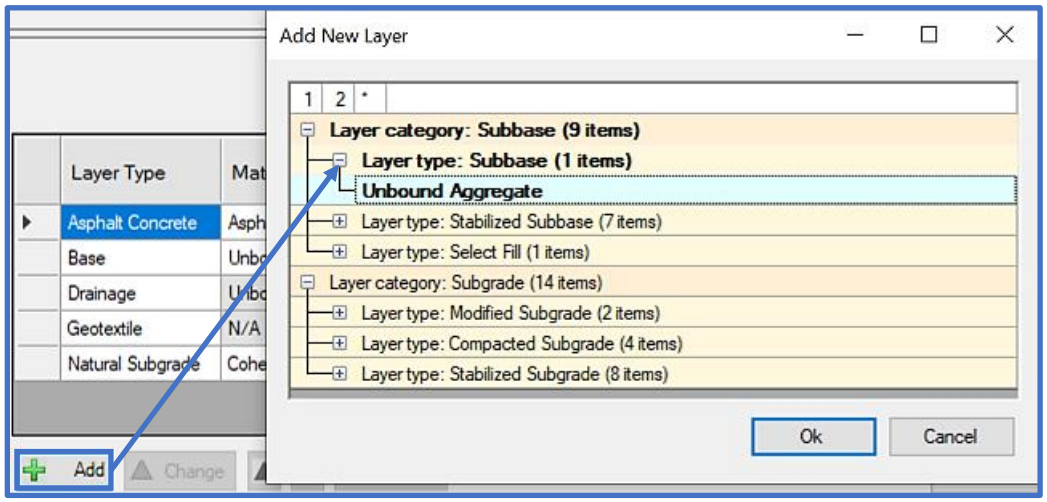

Design Properties
Design:
New
Rename
Create New Design
Design Name
Primary Taxiway
Pavement Use
Airfield
Roadway/Parking
OK
Cancel

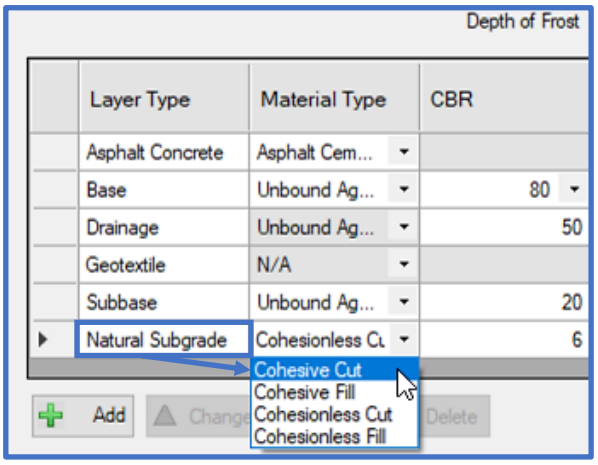

Pavement Use
Airfield
Drainage Layer Thickness
0
in
Set in Current Model
Opens the Calculator for Drainage Thickness.
Drainage Layer Thickness Calculator
Input Parameters
Design Storm Index
1.47
(in./h)
Length of Drainage Path
(ft)
Slope of Drainage Path
(%)
Permeability of Drainage Material
(ft/day)
Effective Porosity
Infiltration Coefficient
0.5
Drainage Path Calculator
Drainage Path Properties
Length of Transverse Slope:
37.5
(ft)
Transverse Slope:
1.00
(%)
Longitudinal Slope:
1.00
(%)
Calculate
moving traffic, then T85 < 10 days. T85 is not
a function of thickness.
Calculate
Close


Drainage Layer Thickness Calculator
Input Parameters
Design Storm Index
1.47
(in./h)
Length of Drainage Path
53
(ft)
Slope of Drainage Path
1.41
(%)
Permeability of Drainage Material
1000
(ft/day)
Effective Porosity
0.15
Infiltration Coefficient
0.5
Results
Minimum Thickness:
4
(in.)
Calculated Thickness:
5.52
(in.)
Required Thickness:
5.52
(in.)
Time for 85% Drainage:
0.56
(days)
Note: Time for 85% drainage (T85) should be
1 day or less unless designing for a parking
apron or other areas of low volume and slow
moving traffic, then T85 < 10 days. T85 is not
a function of thickness.
Calculate
Close


Layer Models in Selected Design
Layer Model Name
Layer Model Type
Analysis Type
Traffic Pattern
Traffic Area
Season Set
Compaction Traffic Class
New
Import
Create New Design Layer Model
Layer Model Name
Primary TW Flexible1
Use Drainage Layer
Pavement Type
Flexible
Traffic Pattern
AIR FORCE HEAVY
Analysis Type
CBR
Traffic Area
Traffic Area A
Ok
Cancel


Layers in Prima
Override calculated depth of frost
Depth of Frost
0
in.
Layer Type
Asphalt Concrete
Base
Drainage
Separation
Natural Subgrade
Change Layer Type
Layer category: Separation (1 items)
Layer type: Geotextile (1 items)
N/A
Ok
Cancel
Add
Change
Delete


Add New Layer
Layer category: Subbase (9 items)
Layer type: Subbase (1 items)
Unbound Aggregate
Layer type: Stabilized Subbase (7 items)
Layer type: Select Fill (1 items)
Layer category: Subgrade (14 items)
Layer type: Modified Subgrade (2 items)
Layer type: Compacted Subgrade (4 items)
Layer type: Stabilized Subgrade (8 items)
Ok
Cancel
Layer Type
Asphalt Concrete
Base
Drainage
Geotextile
N/A
Natural Subgrade
Add
Change


Depth of Frost
Layer Type
Material Type
CBR
Asphalt Concrete
Asphalt Cem...
Base
Unbound Ag...
80
Drainage
Unbound Ag...
50
Geotextile
N/A
Subbase
Unbound Ag...
20
Natural Subgrade
Cohesionless Cu
6
Cohesive Cut
Cohesive Fill
Cohesionless Cut
Cohesionless Fill
Add
Change
Delete

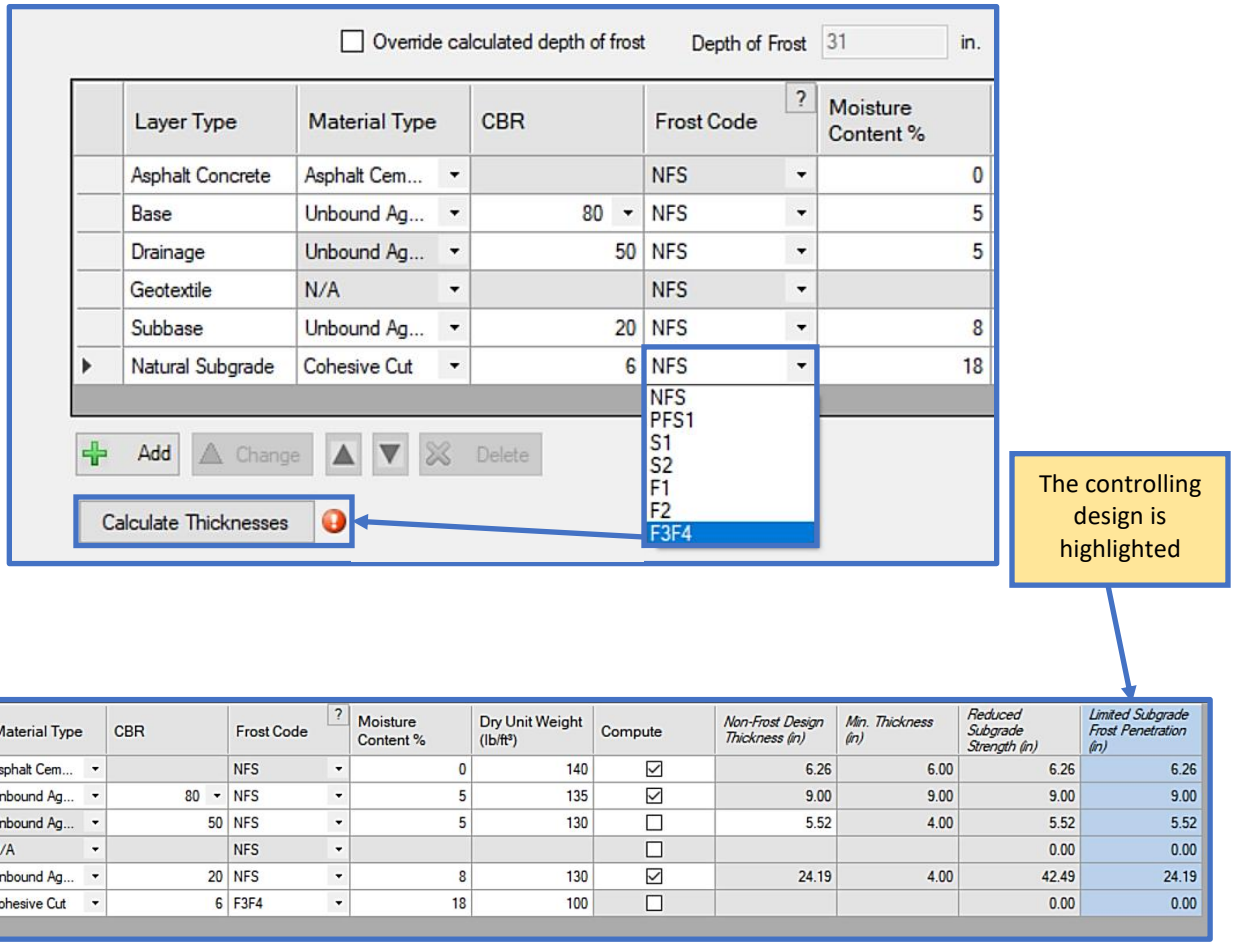
Layers in Primary TW Flexible 1

☐ Override calculated depth of frost Depth of Frost 31 in.

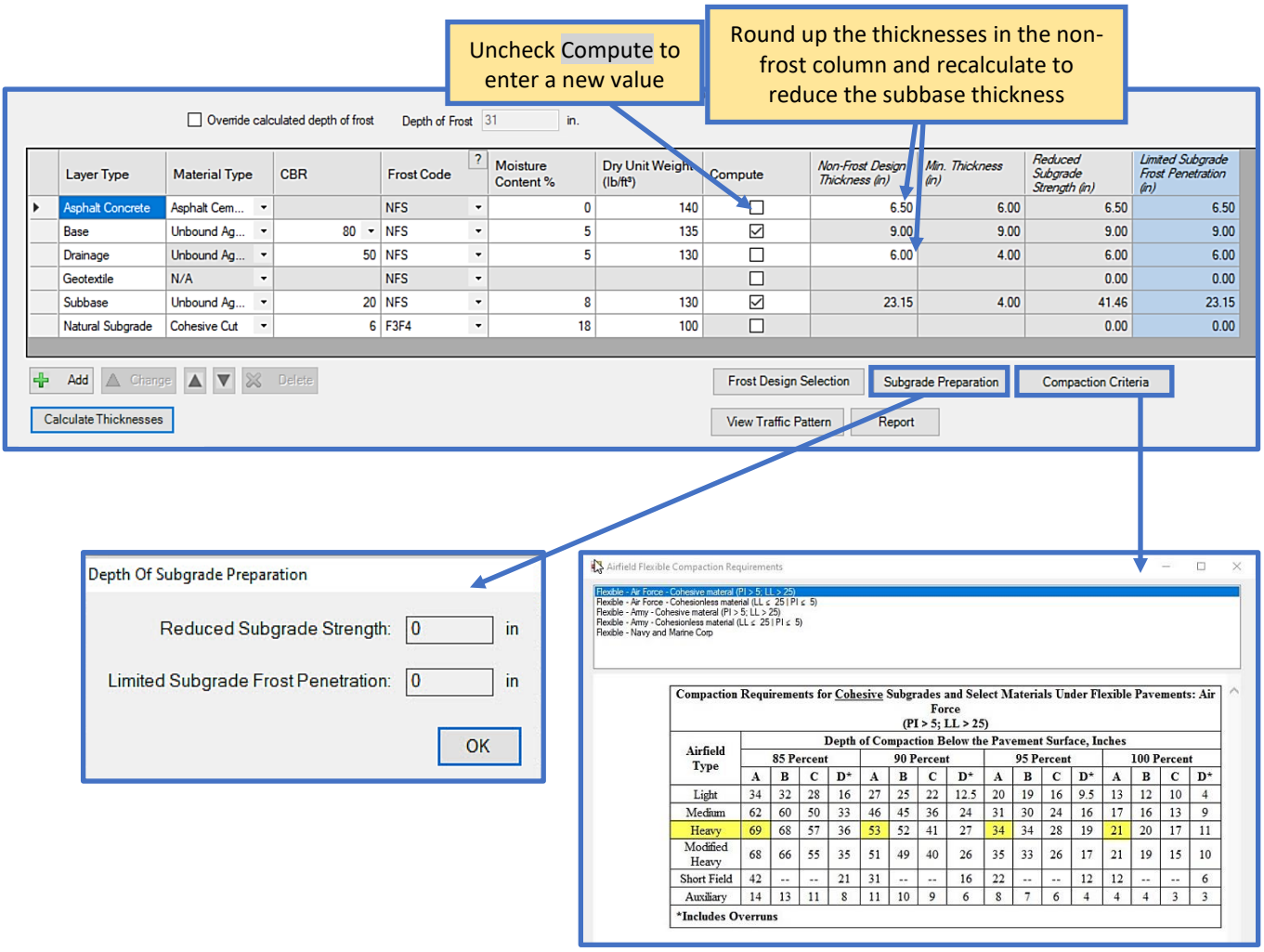
Layer Type	Material Type	CBR	Frost Code	Moisture Content %	Dry Unit Weight (lb/ft³)	Compute	Non-Frost Design Thickness (in)	Min. Thickness (in)	Reduced Subgrade Strength (in)	Limited Subgrade Frost Penetration (in)
Asphalt Concrete	Asphalt Cem...		NFS	0	140	☑	6.00	6.00	0.00	0.00
Base	Unbound Ag...	80	NFS	5	135	☑	9.00	9.00	0.00	0.00
Drainage	Unbound Ag...	50	NFS	5	130	☐	5.52	4.00	0.00	0.00
Geotextile	N/A		NFS			☐			0.00	0.00
Subbase	Unbound Ag...	20	NFS	8	130	☑	4.00	4.00	0.00	0.00
Natural Subgrade	Cohesive Cut	6	NFS	18	100	☐			0.00	0.00

Add Change Delete Compaction Criteria

Calculate Thicknesses View Traffic Pattern Report



Layer Type	Material Type	CBR	Frost Code	Moisture Content %	Dry Unit Weight (lb/ft³)	Compute	Non-Frost Design Thickness (in)	Min. Thickness (in)	Reduced Subgrade Strength (in)	Limited Subgrade Frost Penetration (in)
Asphalt Concrete	Asphalt Cem...		NFS	0	140	☑	6.26	6.00	6.26	6.26
Base	Unbound Ag...	80	NFS	5	135	☑	9.00	9.00	9.00	9.00
Drainage	Unbound Ag...	50	NFS	5	130	☐	5.52	4.00	5.52	5.52
Geotextile	N/A		NFS			☐			0.00	0.00
Subbase	Unbound Ag...	20	NFS	8	130	☑	24.19	4.00	42.49	24.19
Natural Subgrade	Cohesive Cut	6	F3F4	18	100	☐			0.00	0.00

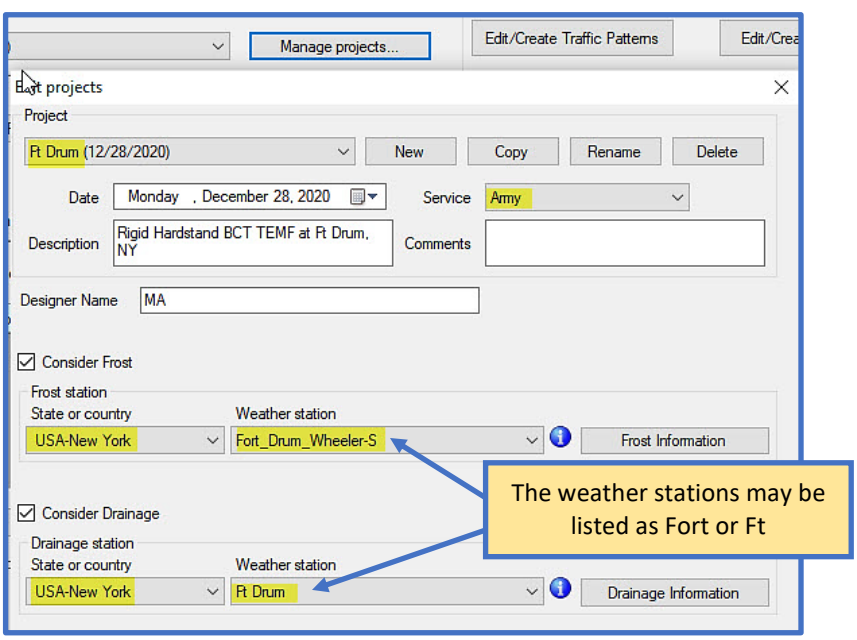


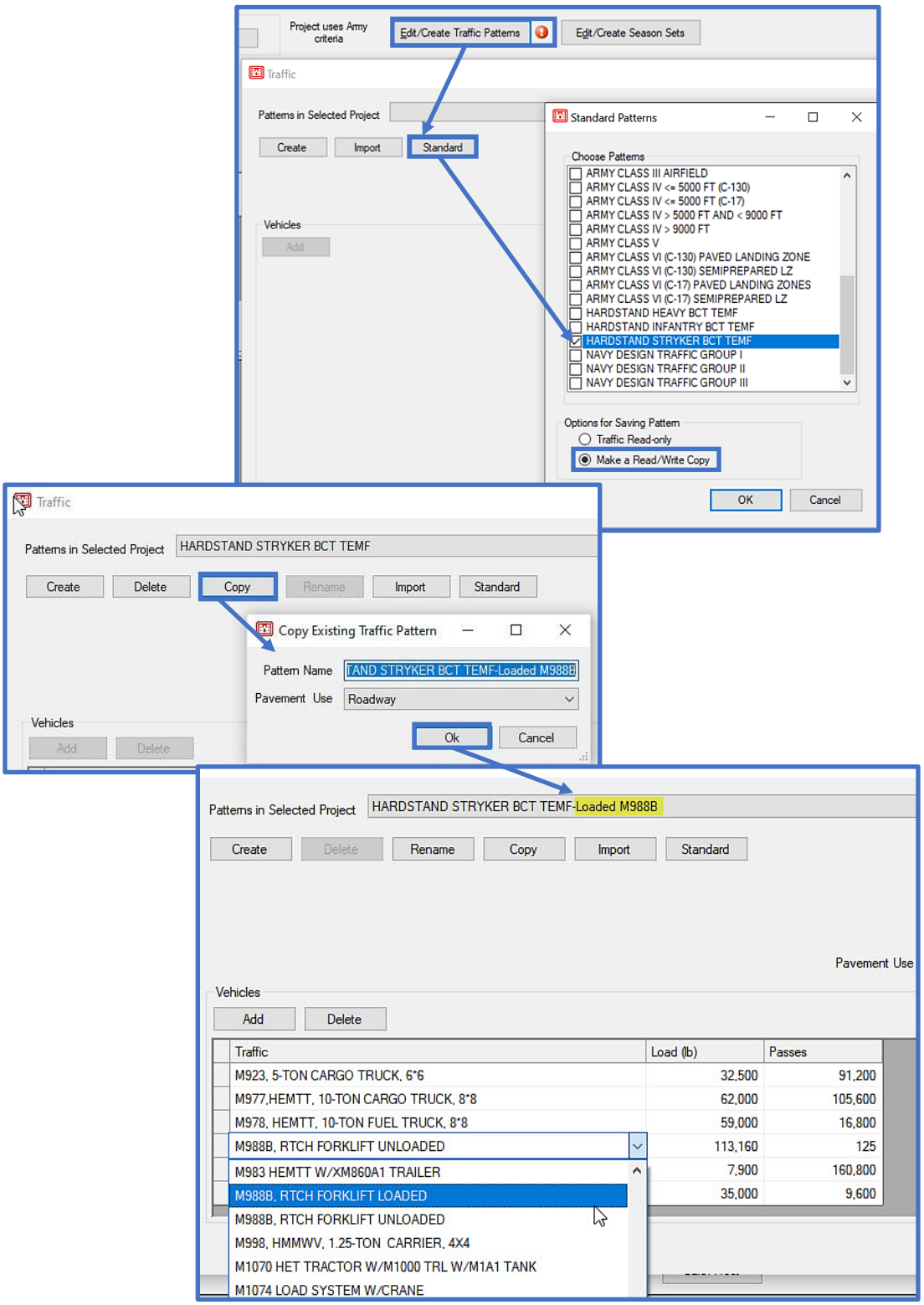
11.5.5 Rigid surfaced parking area using standard traffic in a frost area

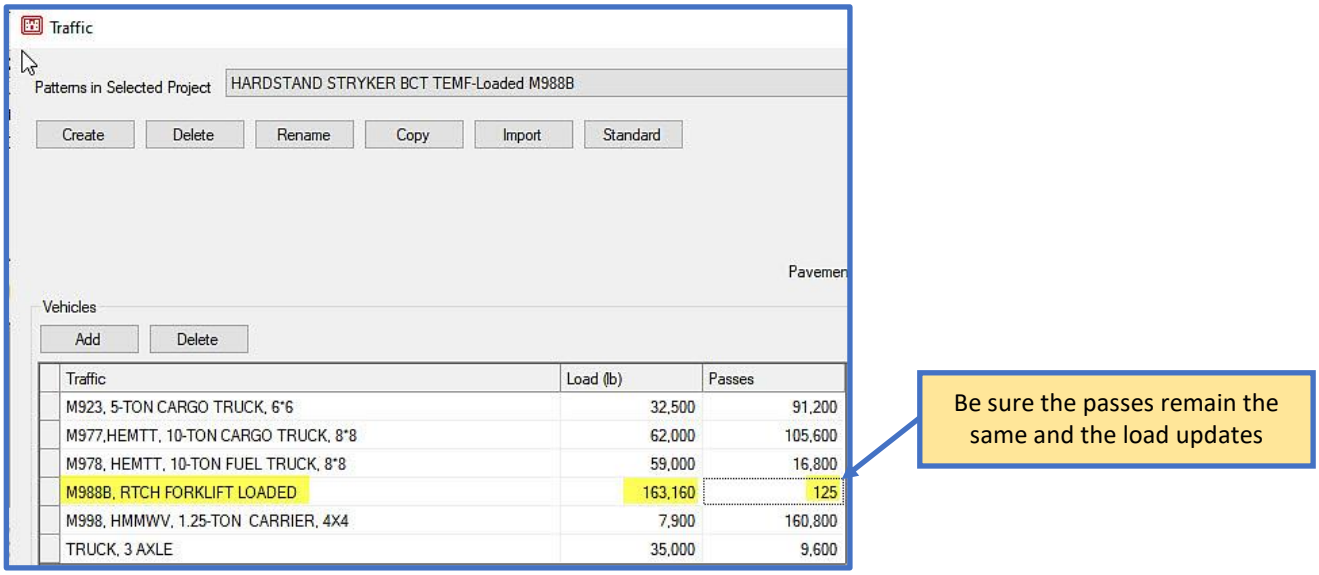
Design a rigid Hardstand pavement for a Stryker Brigade Combat Team (BCT) Tactical Equipment Maintenance Facility (TEMF) at the Army reservation, Fort Drum, New York. Use the standard traffic pattern for this hardstand but change the M988B to the Loaded version. Design the Hardstand using the properties in the table below and keep the default settings for Modulus and Poisson's Ratios.

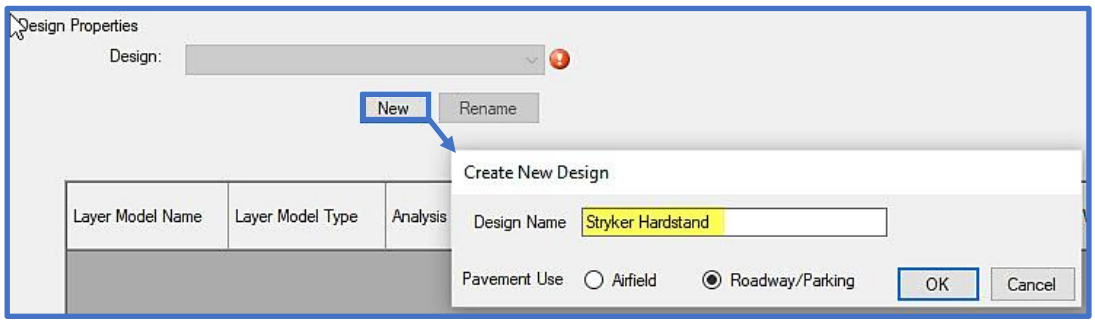
Layer	Description	Frost Code	Design K	Dry Unit Weight pcf	% Moisture
Wearing Surface	Portland Cement Concrete (PCC) Flex Strength = 650 psi	F0	--	145	0
Drainage Layer*	Uniform Graded Coarse Sand	F0	--	130	5
Separation Layer	Unbound aggregate	F0	--	130	8
Subgrade	SP Cohesionless Cut	F2	150	120	10

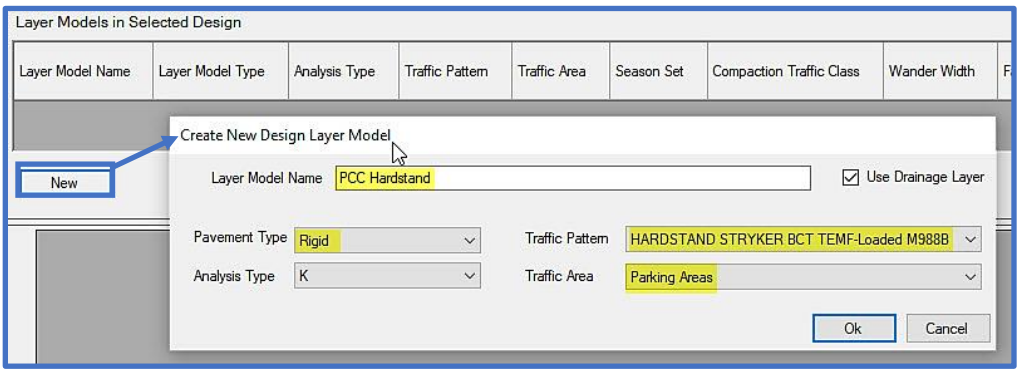
***Drainage Layer Parameters**	
Precipitation Data	Ft. Drum
Length of transverse slope	800 ft
Transverse slope	1.50%
Longitudinal slope	1.50%
Permeability of drainage material	2,500 ft/day
Effective Porosity	0.25
Infiltration Coefficient	0.5

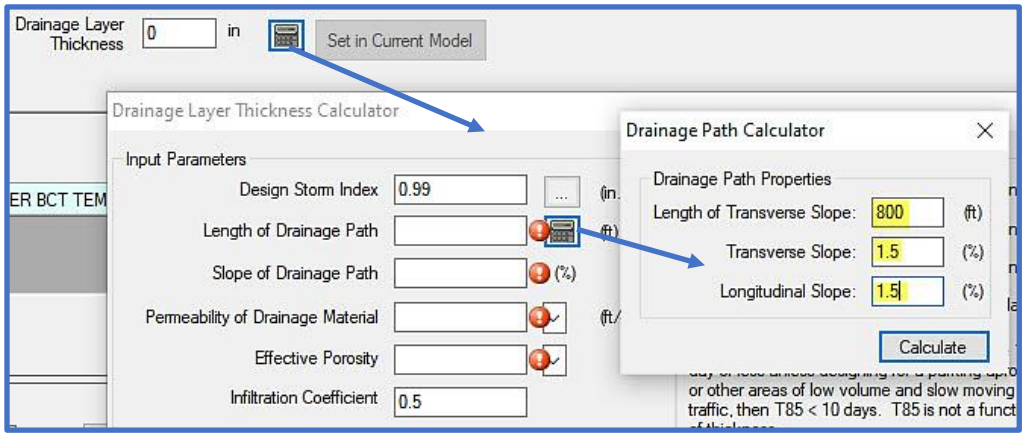


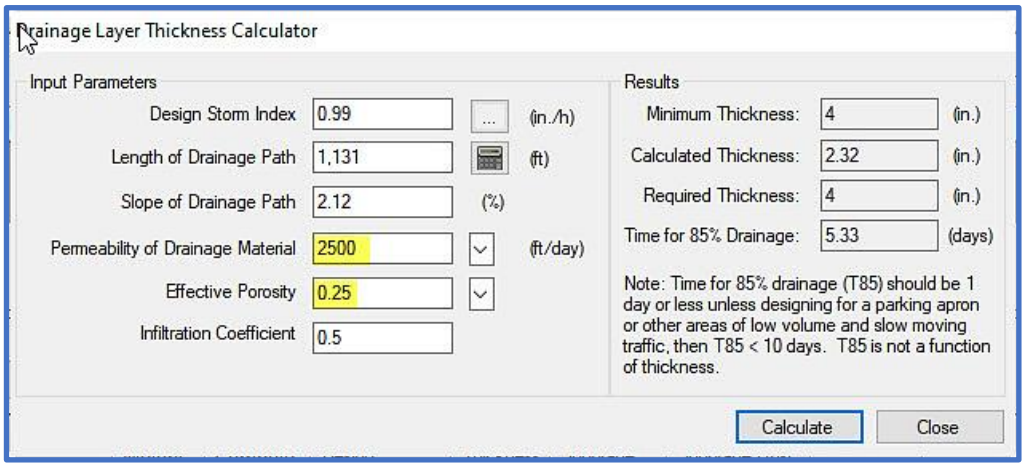

Project uses Army criteria
Edit/Create Traffic Patterns
Edit/Create Season Sets
Traffic
Patterns in Selected Project
Create
Import
Standard
Vehicles
Add
Standard Patterns
Choose Patterns
ARMY CLASS III AIRFIELD
ARMY CLASS IV <= 5000 FT (C-130)
ARMY CLASS IV <= 5000 FT (C-17)
ARMY CLASS IV > 5000 FT AND < 9000 FT
ARMY CLASS IV > 9000 FT
ARMY CLASS V
ARMY CLASS VI (C-130) PAVED LANDING ZONE
ARMY CLASS VI (C-130) SEMIPREPARED LZ
ARMY CLASS VI (C-17) PAVED LANDING ZONES
ARMY CLASS VI (C-17) SEMIPREPARED LZ
HARDSTAND HEAVY BCT TEMF
HARDSTAND INFANTRY BCT TEMF
HARDSTAND STRYKER BCT TEMF
NAVY DESIGN TRAFFIC GROUP I
NAVY DESIGN TRAFFIC GROUP II
NAVY DESIGN TRAFFIC GROUP III
Options for Saving Pattern
Traffic Read-only
Make a Read/Write Copy
OK
Cancel
Traffic
Patterns in Selected Project
HARDSTAND STRYKER BCT TEMF
Create
Delete
Copy
Rename
Import
Standard
Copy Existing Traffic Pattern
Pattern Name
TAND STRYKER BCT TEMF-Loaded M988B
Pavement Use
Roadway
Ok
Cancel
Vehicles
Add
Delete
Patterns in Selected Project
HARDSTAND STRYKER BCT TEMF-Loaded M988B
Create
Delete
Rename
Copy
Import
Standard
Pavement Use
Vehicles
Add
Delete
Traffic
Load (lb)
Passes
M923, 5-TON CARGO TRUCK, 6*6
32,500
91,200
M977,HEMTT, 10-TON CARGO TRUCK, 8*8
62,000
105,600
M978, HEMTT, 10-TON FUEL TRUCK, 8*8
59,000
16,800
M988B, RTCH FORKLIFT UNLOADED
113,160
125
M983 HEMTT W/XM860A1 TRAILER
7,900
160,800
M988B, RTCH FORKLIFT LOADED
35,000
9,600
M988B, RTCH FORKLIFT UNLOADED
M998, HMMWV, 1.25-TON CARRIER, 4X4
M1070 HET TRACTOR W/M1000 TRL W/M1A1 TANK
M1074 LOAD SYSTEM W/CRANE

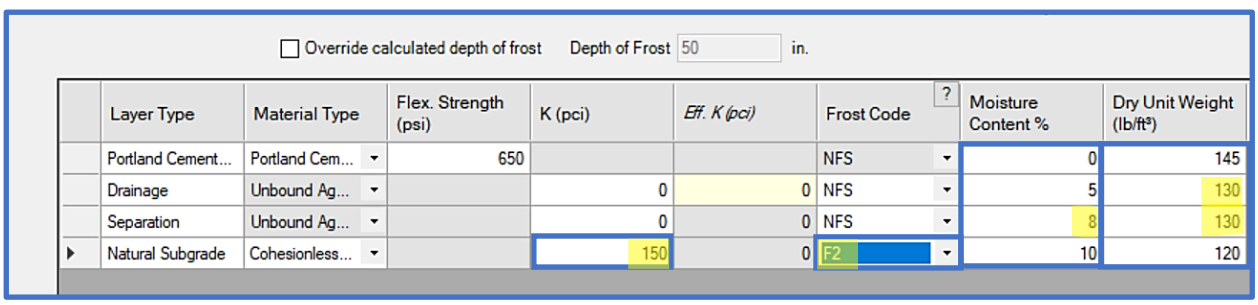

Traffic
Patterns in Selected Project
HARDSTAND STRYKER BCT TEMF-Loaded M988B
Create
Delete
Rename
Copy
Import
Standard
Pavemen
Vehicles
Add
Delete
Traffic
Load (lb)
Passes
M923, 5-TON CARGO TRUCK, 6*6
32,500
91,200
M977,HEMTT, 10-TON CARGO TRUCK, 8*8
62,000
105,600
M978, HEMTT, 10-TON FUEL TRUCK, 8*8
59,000
16,800
M988B, RTCH FORKLIFT LOADED
163,160
125
M998, HMMWV, 1.25-TON CARRIER, 4X4
7,900
160,800
TRUCK, 3 AXLE
35,000
9,600
Be sure the passes remain the same and the load updates


Design Properties
Design:
New
Rename
Layer Model Name
Layer Model Type
Analysis
Create New Design
Design Name
Stryker Hardstand
Pavement Use
Airfield
Roadway/Parking
OK
Cancel


Layer Models in Selected Design
Layer Model Name
Layer Model Type
Analysis Type
Traffic Pattern
Traffic Area
Season Set
Compaction Traffic Class
Wander Width
New
Create New Design Layer Model
Layer Model Name
PCC Hardstand
Use Drainage Layer
Pavement Type
Rigid
Traffic Pattern
HARDSTAND STRYKER BCT TEMF-Loaded M988B
Analysis Type
K
Traffic Area
Parking Areas
Ok
Cancel







Layer Type	Material Type	Flex. Strength (psi)	K (pci)	*Eff. K (pci)*	Frost Code	Moisture Content %	Dry Unit Weight (lb/ft³)
Portland Cement...	Portland Cem...	650			NFS	0	145
Drainage	Unbound Ag...		0	0	NFS	5	130
Separation	Unbound Ag...		0	0	NFS	8	130
Natural Subgrade	Cohesionless...		150	0	F2	10	120

Layer Models in Selected Design

Layer Model Name	Layer Model Type	Analysis Type	Traffic Pattern	Traffic Area	Season Set	Compaction Traffic Class	Wander Width (in.)	Failure SCI	Estimated AASHTO ESALs
PCC Hardstand	**Rigid**	**K**	**HARDSTAND STRYKER BCT TEMF-Loaded**	**Parking Areas**	**All Year**	**Roads Structural**	33.35	**N/A**	**4,861,146**

Be sure the correct traffic pattern and traffic area are selected

PCC Surface Layer Properties
% Steel 0.0 Load Transfer % 25

Parking Areas increases the Load Transfer to 25%

Layers in PCC Hardstand

Override calculated depth of frost Depth of Frost 49 in.

Layer Type	Material Type	Flex. Strength (psi)	K (pci)	*Eff. K (pci)*	Frost Code	Moisture Content %	Dry Unit Weight (lb/ft³)	Compute	*Non-Frost Design Thickness (in)*	*Min. Thickness (in)*	*Reduced Subgrade Strength (in)*	*Limited Subgrade Frost Penetration (in)*	Modulus (psi)	Poisson's Ratio
Portland Cement...	Portland Cem...	650			NFS	0	145	☑	10.11	6.00	12.51	10.11	4,000,000	0.15
Drainage	Unbound Ag...		0	230	NFS	5	130	☐	4.00	4.00	4.00	4.00		
Separation	Unbound Ag...		0	190	NFS	8	130	☐	4.00	4.00	4.00	24.29		
Natural Subgrade	Cohesionless...		150	150	F2	10	120	☐			0.00	0.00		

Design - Project Fort Drum

Project
Fort Drum (12/28/2020) Manage projects...

Project uses Air Force criteria | Edit/Create Traffic Patterns | Edit/Create Season Sets | Project Report

Design Properties
Design: Stryker Hardstand
New Copy Rename Delete

Pavement Use: Roadway/Parking
Drainage Layer Thickness 4 in Set in Current Model

Layer Models in Selected Design

Layer Model Name	Layer Model Type	Analysis Type	Traffic Pattern	Traffic Area	Season Set	Compaction Traffic Class	Wander Width (in.)	Failure SCI	Estimated AASHTO ESALs
PCC Hardstand	**Rigid**	**K**	**HARDSTAND STRYKER BCT TEMF-Loaded**	**Parking Areas**	**All Year**	**Roads Structural**	33.35	**N/A**	**3,501,575**

New Copy Import Delete

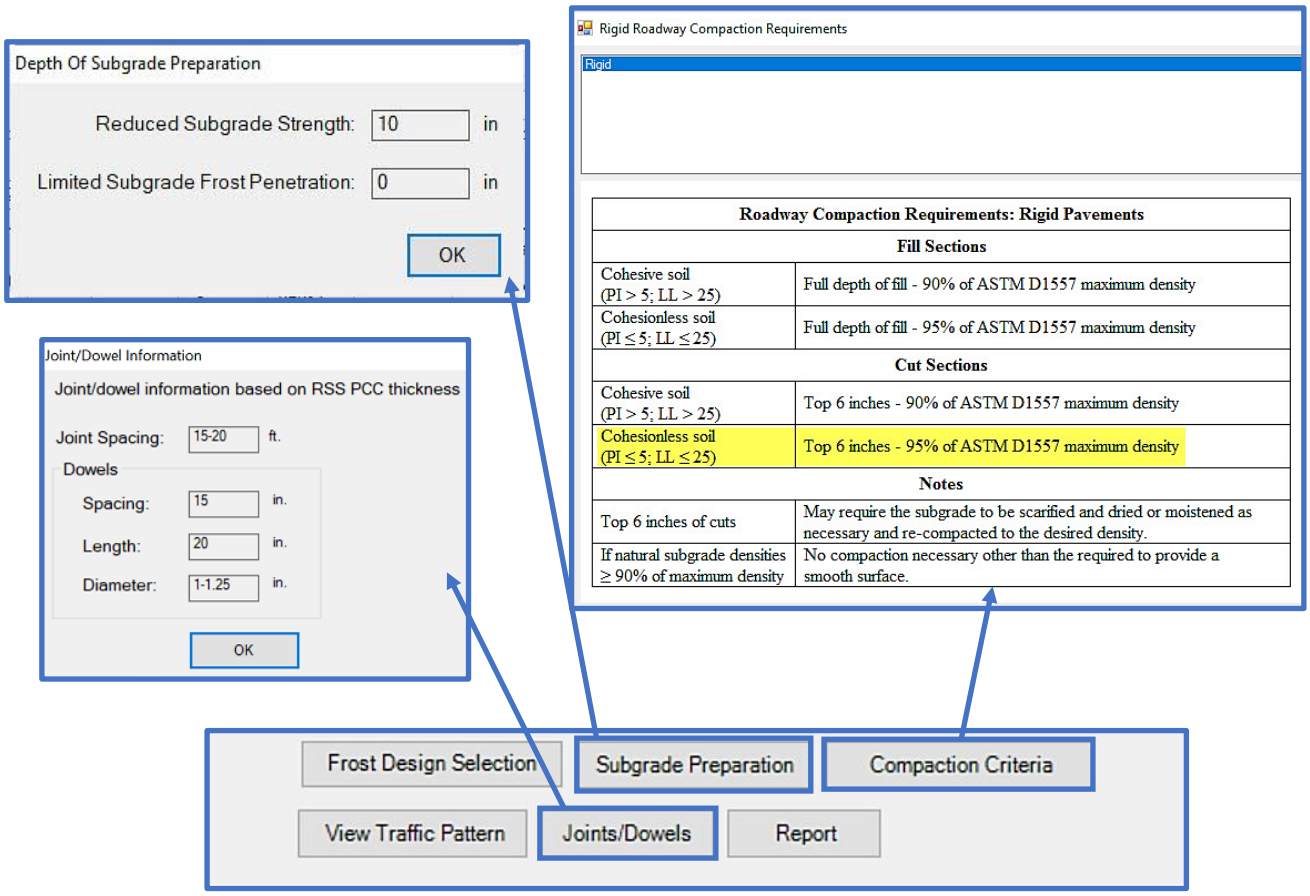
PCC Surface Layer Properties
% Steel 0.0 Load Transfer %

Adjust the Separation Layer thickness to reduce the PCC thickness, which creates a more economical design – be sure to recalculate the Depth of Frost

Layers in PCC Hardstan

Override calculated depth of frost Depth of Frost 50 in.

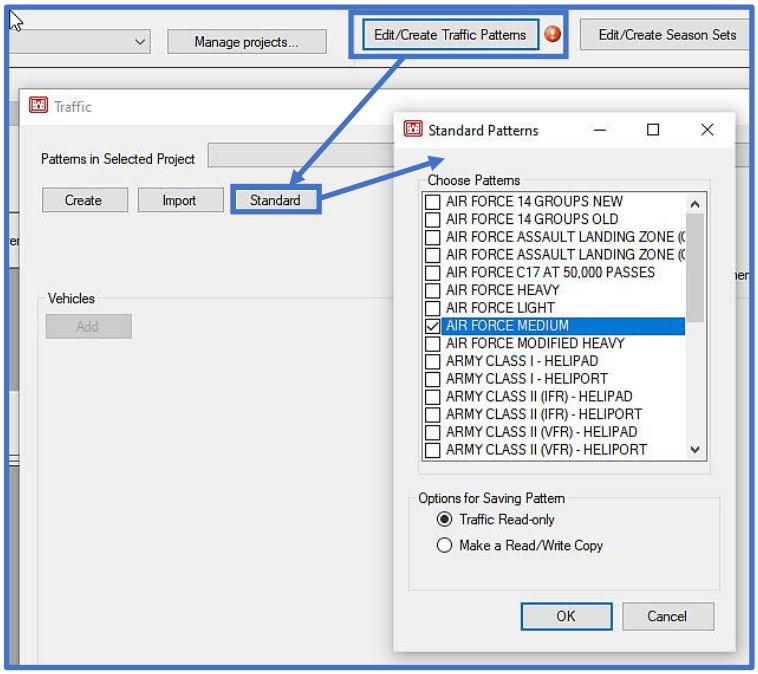
Layer Type	Material Type	Flex. Strength (psi)	K (pci)	*Eff. K (pci)*	Frost Code	Moisture Content %	Dry Unit Weight (lb/ft³)	Compute	*Non-Frost Design Thickness (in)*	*Min. Thickness (in)*	*Reduced Subgrade Strength (in)*	*Limited Subgrade Frost Penetration (in)*	Modulus (psi)	Poisson's Ratio
Portland Cement...	Portland Cem...	650			NFS	0	145	☑	9.66	6.00	11.82	9.66	4,000,000	0.15
Drainage	Unbound Ag...		0	262	NFS	5	130	☐	4.00	4.00	4.00	4.00		
Separation	Unbound Ag...		0	226	NFS	8	130	☐	8.00	4.00	8.00	26.45		
Natural Subgrade	Cohesionless...		150	150	F2	10	120	☐			0.00	0.00		

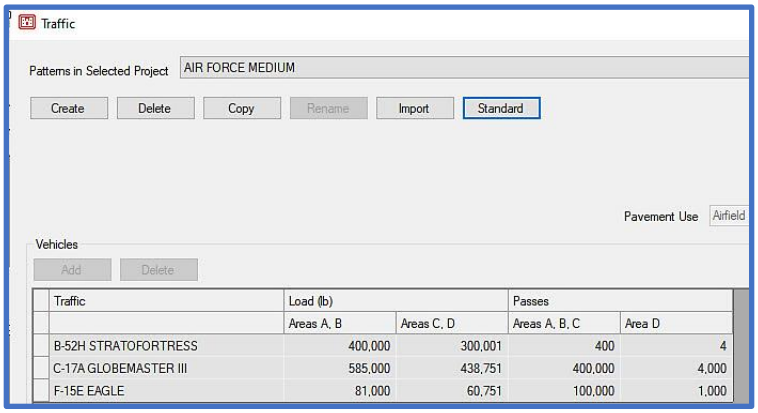


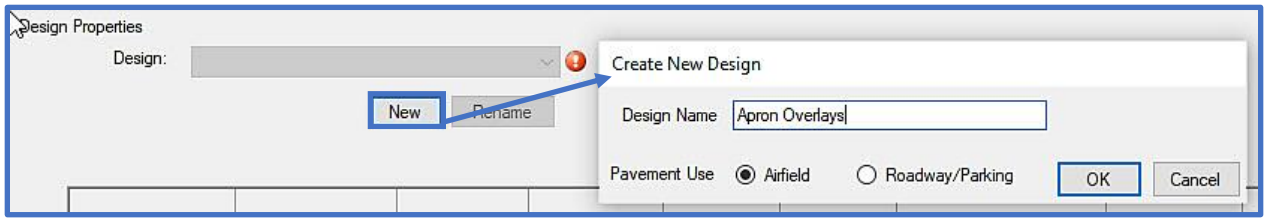
11.5.6 Overlays for an existing rigid airfield pavement

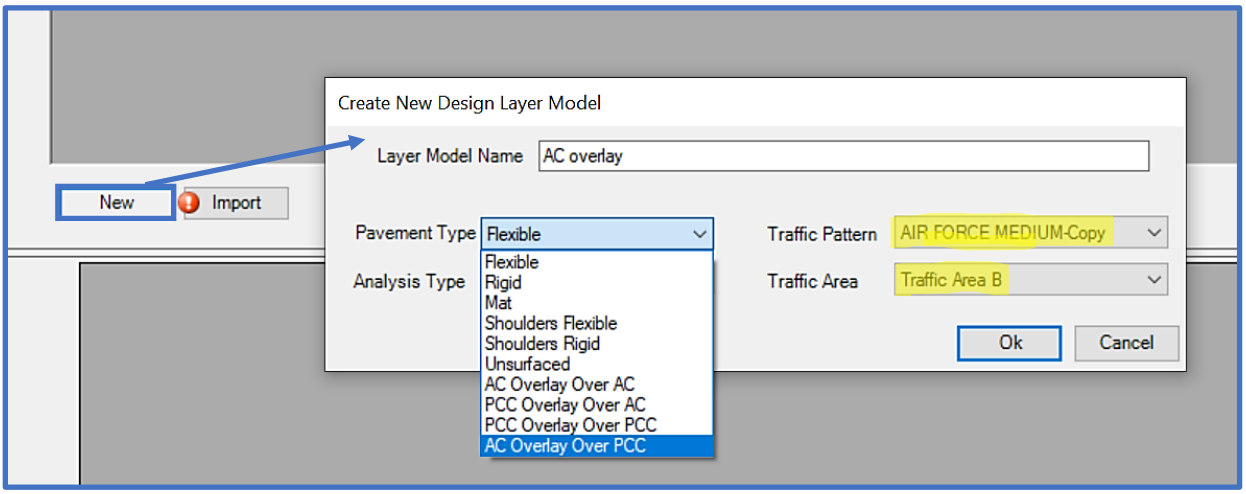
An existing rigid apron (Traffic Area B) requires an overlay to support the Air Force Medium traffic. Design overlays (AC, PCC partially bonded and PCC unbonded) for the existing structure described in the table below. The apron is in poor condition (PCI=48) with 55% of the distresses due to load.

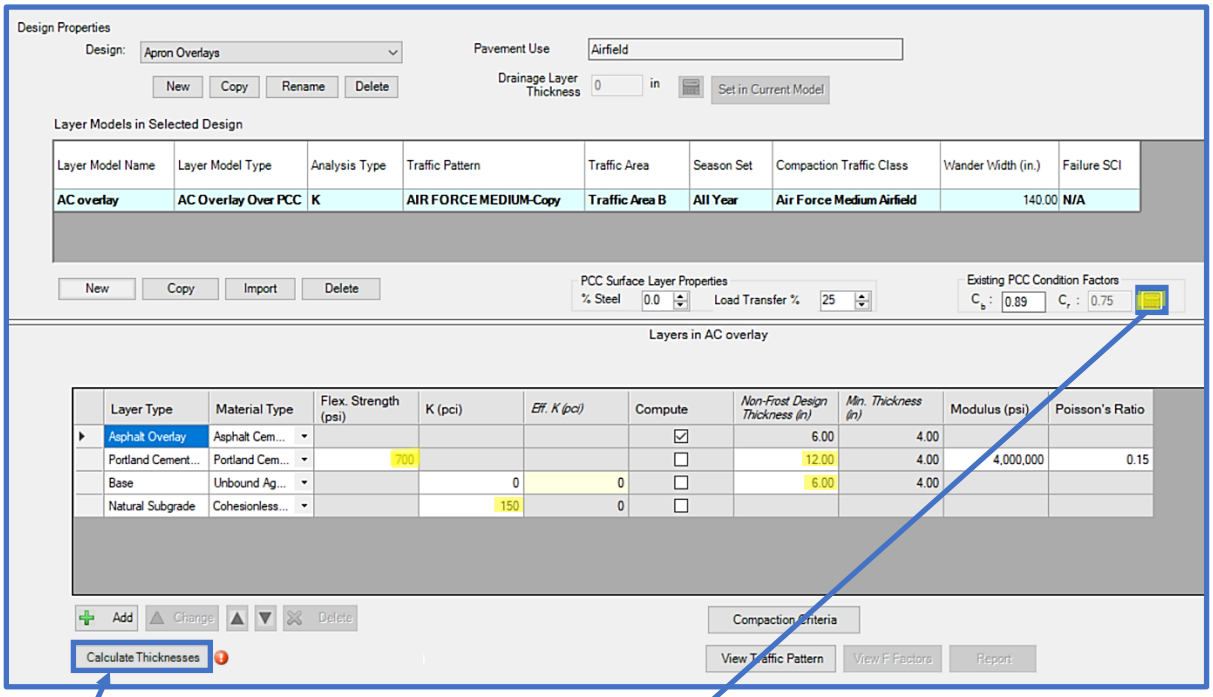
Layer	Thickness - inches	Flex Strength - psi	K- pci
Portland Cement Concrete (PCC)	12.0	700	--
Aggregate Base Course	6.0	--	--
Subgrade	--	--	150


Manage projects...
Edit/Create Traffic Patterns
Edit/Create Season Sets
Traffic
Patterns in Selected Project
Create
Import
Standard
Vehicles
Add
Standard Patterns
Choose Patterns
AIR FORCE 14 GROUPS NEW
AIR FORCE 14 GROUPS OLD
AIR FORCE ASSAULT LANDING ZONE (
AIR FORCE ASSAULT LANDING ZONE (
AIR FORCE C17 AT 50,000 PASSES
AIR FORCE HEAVY
AIR FORCE LIGHT
AIR FORCE MEDIUM
AIR FORCE MODIFIED HEAVY
ARMY CLASS I - HELIPAD
ARMY CLASS I - HELIPORT
ARMY CLASS II (IFR) - HELIPAD
ARMY CLASS II (IFR) - HELIPORT
ARMY CLASS II (VFR) - HELIPAD
ARMY CLASS II (VFR) - HELIPORT
Options for Saving Pattern
Traffic Read-only
Make a Read/Write Copy
OK
Cancel

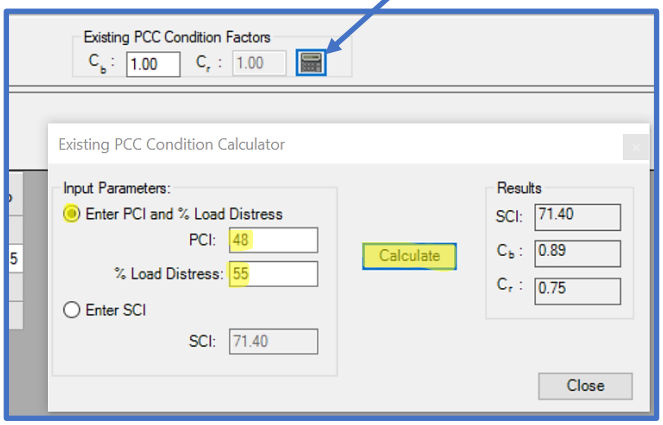

Traffic
Patterns in Selected Project
AIR FORCE MEDIUM
Create
Delete
Copy
Rename
Import
Standard
Pavement Use
Airfield
Vehicles
Add
Delete
Traffic
Load (lb)
Passes
Areas A, B
Areas C, D
Areas A, B, C
Area D
B-52H STRATOFORTRESS 400,000 300,001 400 4
C-17A GLOBEMASTER III 585,000 438,751 400,000 4,000
F-15E EAGLE 81,000 60,751 100,000 1,000

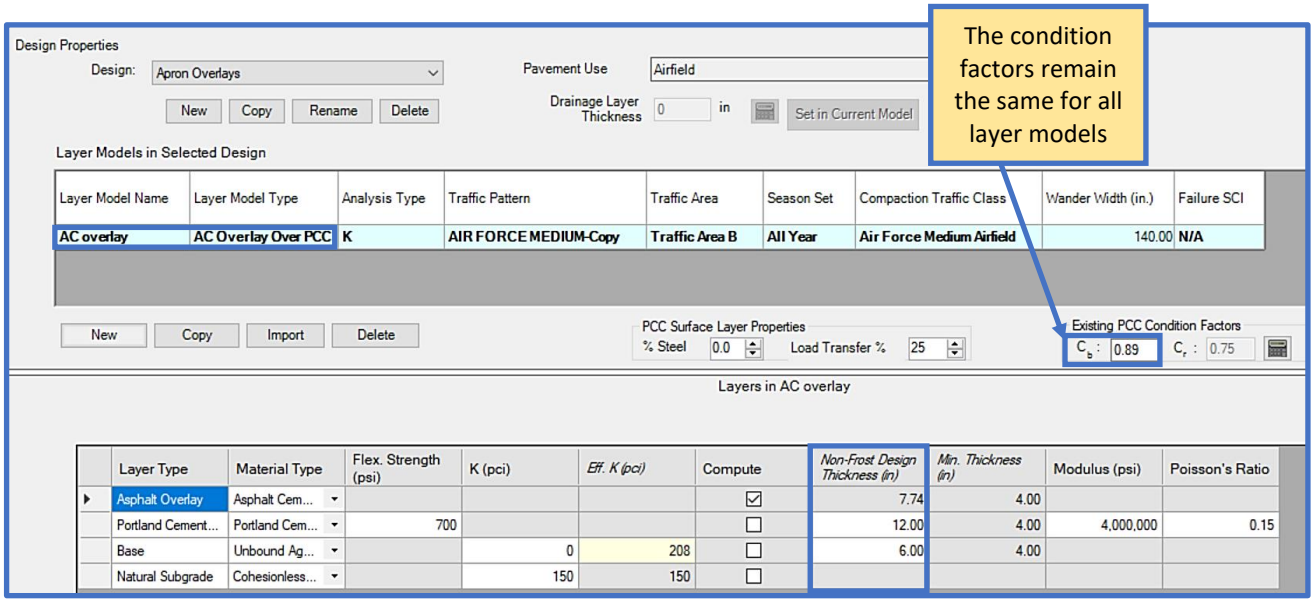

Design Properties
Design:
New
Rename
Create New Design
Design Name
Apron Overlays
Pavement Use
Airfield
Roadway/Parking
OK
Cancel



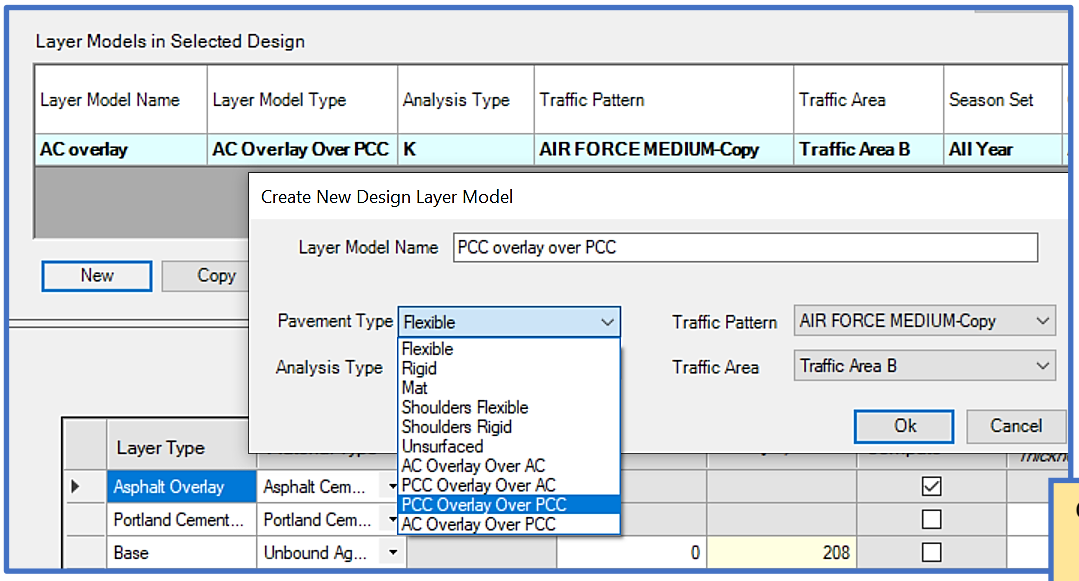


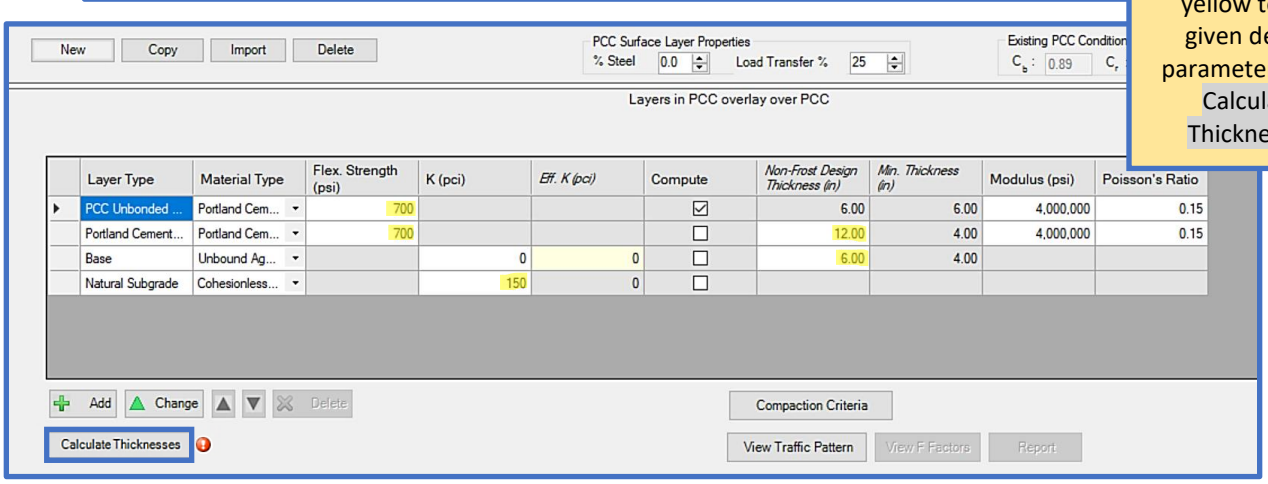
Change the values highlighted in yellow to the given design parameters then Calculate Thicknesses





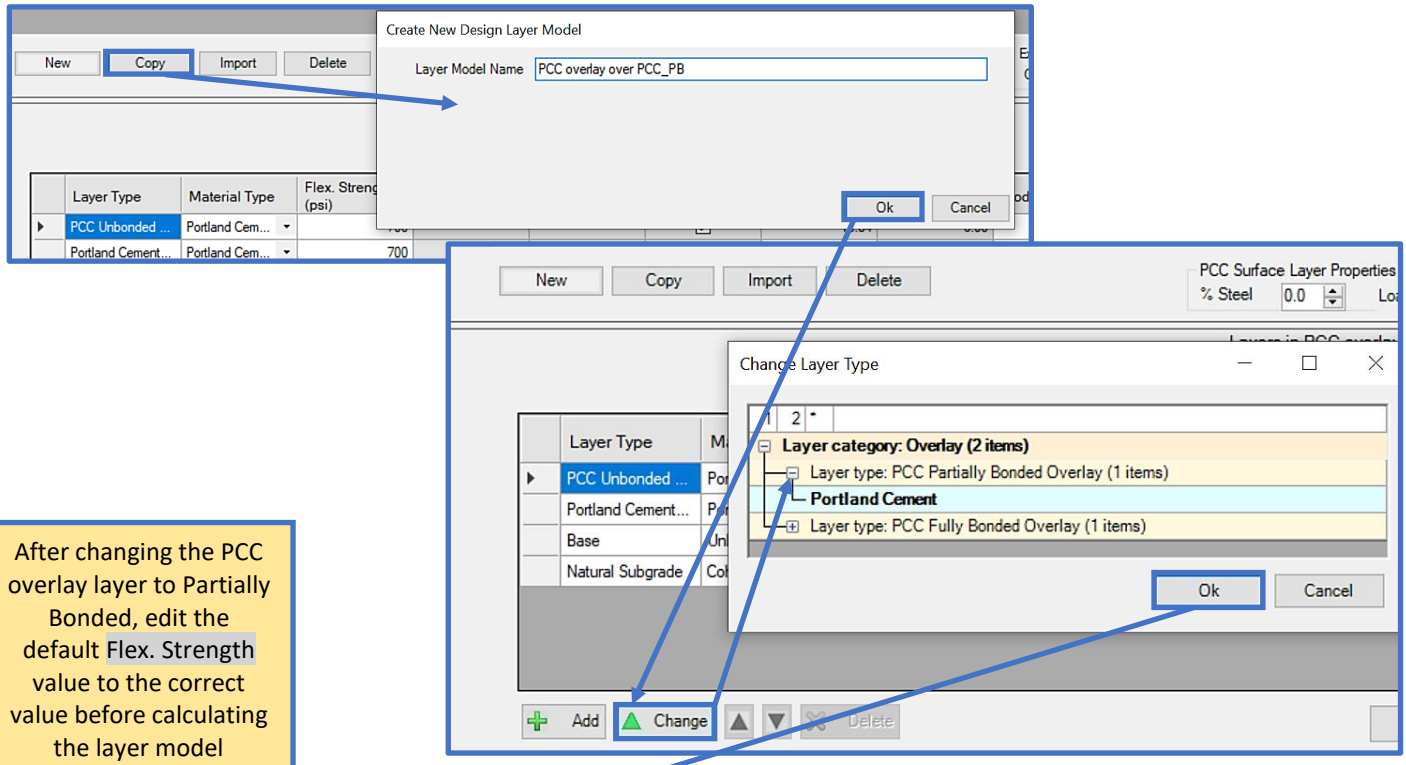
The condition factors remain the same for all layer models





Change the values highlighted in yellow to the given design parameters then Calculate Thicknesses

Layer Type	Material Type	Flex. Strength (psi)	K (pci)	*Eff. K (pci)*	Compute	*Non-Frost Design Thickness (in)*	*Min. Thickness (in)*	Modulus (psi)	Poisson's Ratio
PCC Unbonded ...	Portland Cem...	700			☑	10.84	6.00	4,000,000	0.15
Portland Cement...	Portland Cem...	700			☐	12.00	4.00	4,000,000	0.15
Base	Unbound Ag...		0	208	☐	6.00	4.00		
Natural Subgrade	Cohesionless...		150	150	☐				



After changing the PCC overlay layer to Partially Bonded, edit the default Flex. Strength value to the correct value before calculating the layer model

Layer Type	Material Type	Flex. Strength (psi)	K (pci)	*Eff. K (pci)*	Compute	*Non-Frost Design Thickness (in)*	*Min. Thickness (in)*	Modulus (psi)	Poisson's Ratio
PCC Partially Bo...	Portland Cem...	700			☑	8.51	6.00	4,000,000	0.15
Portland Cement...	Portland Cem...	700			☐	12.00	4.00	4,000,000	0.15
Base	Unbound Ag...		0	208	☐	6.00	4.00		
Natural Subgrade	Cohesionless...		150	150	☐				

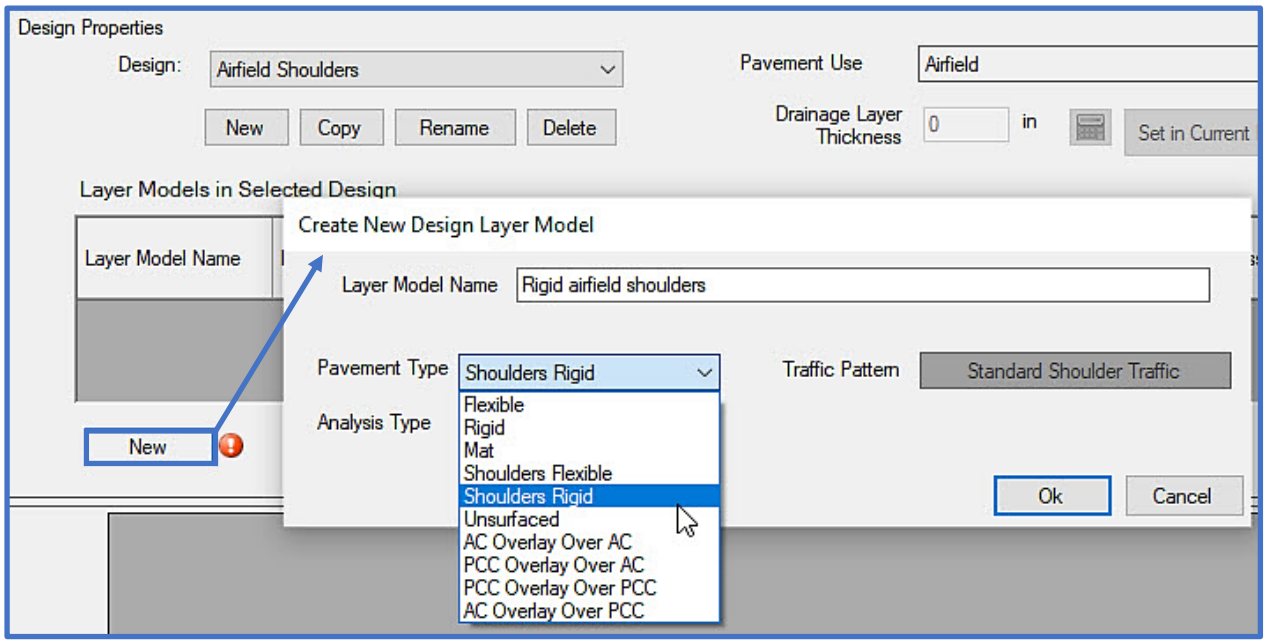
Add | Change | Delete | Compaction Criteria

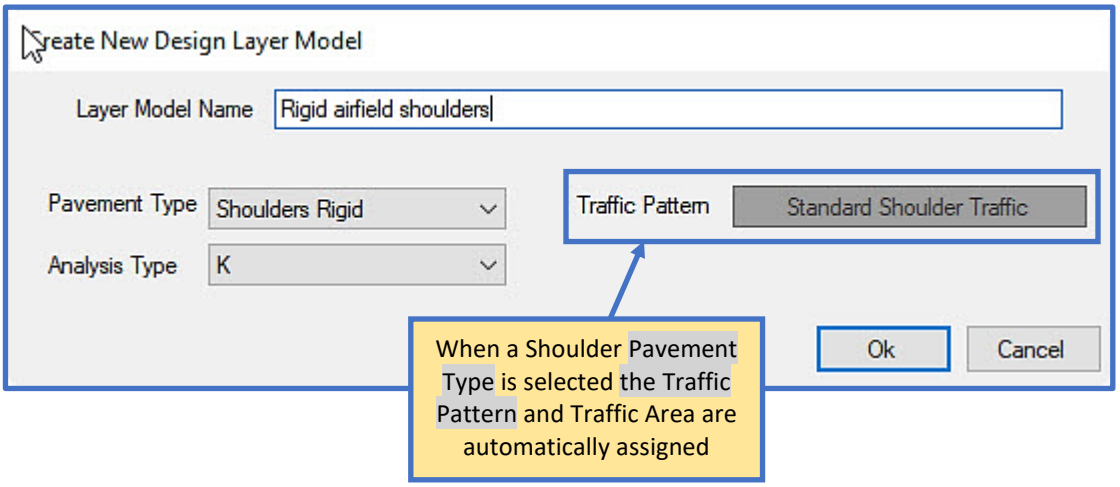
Calculate Thickness | View Traffic Pattern | View F Factors | Joints/Dowels | Report

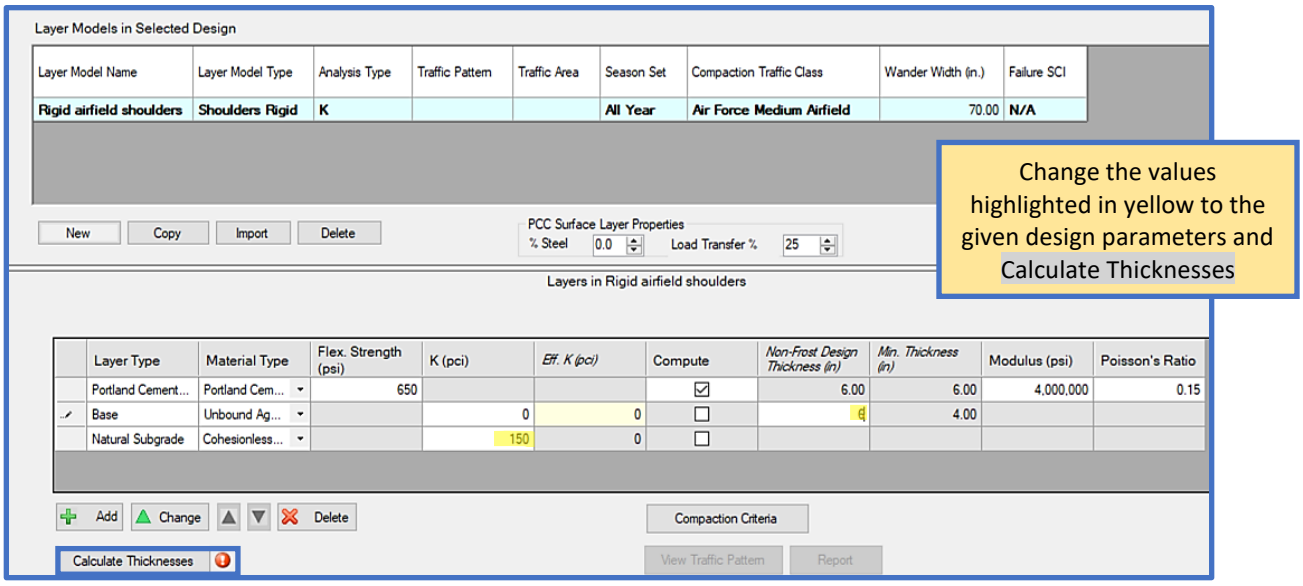
11.5.7 Airfield shoulder pavement

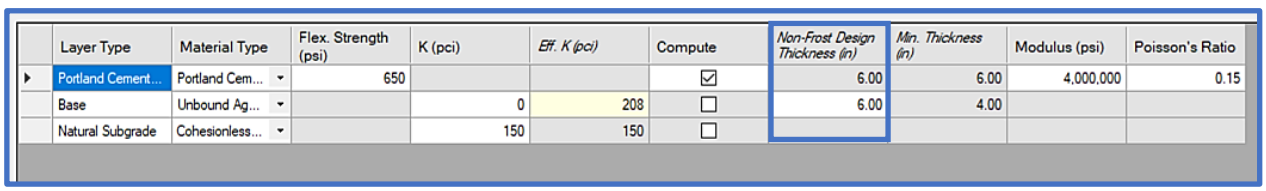
Design a rigid shoulder pavement using the properties in the table below and the default settings for Modulus and Poisson's Ratios.

Layer	Thickness - inches	Flex Strength - psi	K- pci
Portland Cement Concrete (PCC)		650	--
Aggregate Base Course	6.0	--	--
Subgrade	--	--	150






Layer Models in Selected Design
Layer Model Name
Layer Model Type
Analysis Type
Traffic Pattern
Traffic Area
Season Set
Compaction Traffic Class
Wander Width (in.)
Failure SCI
Rigid airfield shoulders
Shoulders Rigid
K
All Year
Air Force Medium Airfield
70.00
N/A
New
Copy
Import
Delete
PCC Surface Layer Properties
% Steel
0.0
Load Transfer %
25
Layers in Rigid airfield shoulders
Layer Type
Material Type
Flex. Strength (psi)
K (pci)
Eff. K (pci)
Compute
Non-Frost Design Thickness (in)
Min. Thickness (in)
Modulus (psi)
Poisson's Ratio
Portland Cement...
Portland Cem...
650
6.00
6.00
4,000,000
0.15
Base
Unbound Ag...
0
0
4.00
Natural Subgrade
Cohesionless...
150
0
Add
Change
Delete
Compaction Criteria
Calculate Thicknesses
View Traffic Pattern
Report
Change the values highlighted in yellow to the given design parameters and Calculate Thicknesses


Layer Type
Material Type
Flex. Strength (psi)
K (pci)
Eff. K (pci)
Compute
Non-Frost Design Thickness (in)
Min. Thickness (in)
Modulus (psi)
Poisson's Ratio
Portland Cement...
Portland Cem...
650
6.00
6.00
4,000,000
0.15
Base
Unbound Ag...
0
208
6.00
4.00
Natural Subgrade
Cohesionless...
150
150

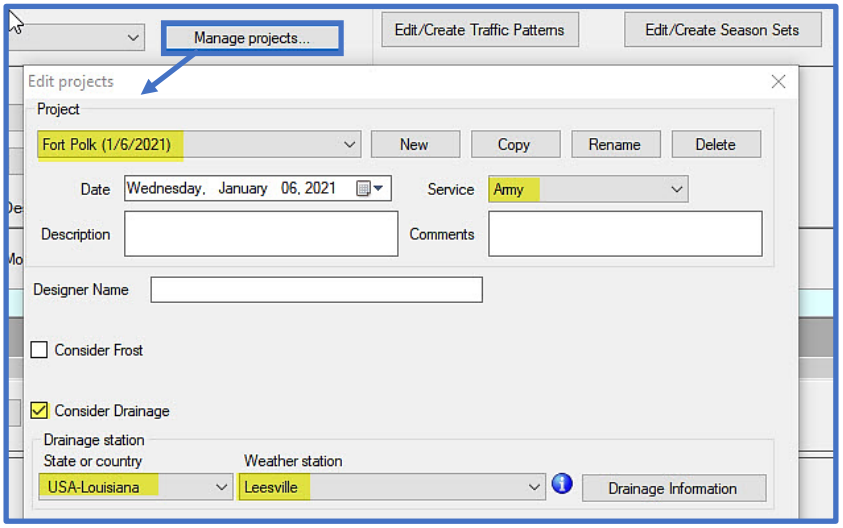
11.5.8 Flexible surfaced airfield using Layered Elastic Design; one season

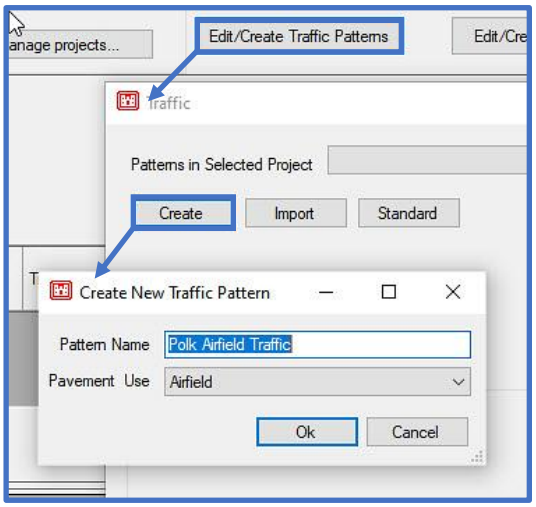
Design a flexible primary taxiway at Fort Polk, Louisiana, using the traffic in Table 1 and material information in Table 2.

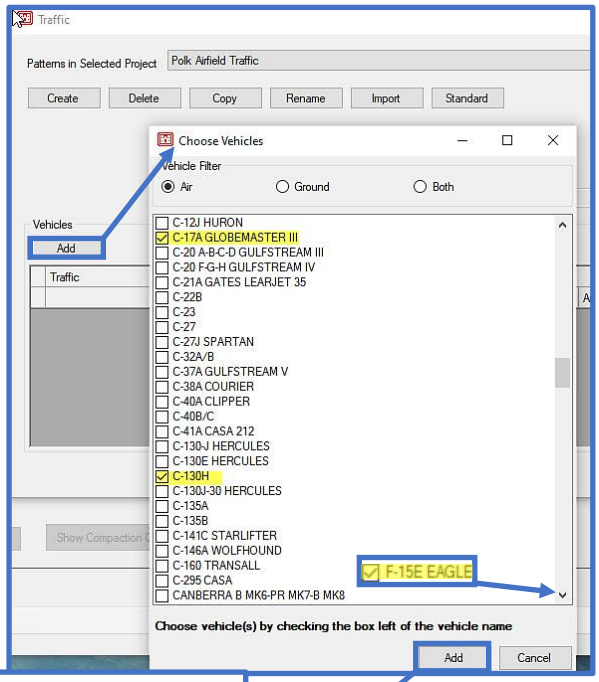
Table 1 – Polk Airfield Traffic		
Vehicle	**Weight (lb)**	**Passes**
C-17A	585,000	5,500
C-130H	155,000	10,500
F-15E	81,000	29,000

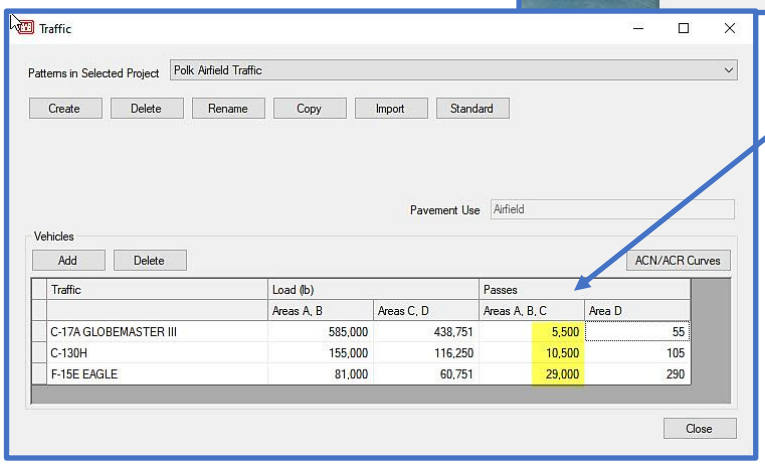
Table 2				
Layer	**Description**	**Modulus (psi)**	**Poisson's Ratio**	**Bond**
Wearing Surface	Asphalt Concrete (AC)	350,000	0.35	Fully Bonded
Base Course	Unbound aggregate	60,000	0.35	Fully Bonded
Drainage Layer*	Unbound aggregate	45,000	0.35	Fully Bonded
Separation Layer	Geotextile	--	--	--
Natural Subgrade	CH (cohesive cut)	20,000	0.40	0

*Drainage Layer Parameters	
Precipitation Data	Leesville, LA
Length of transverse slope	100 ft
Transverse slope	1.50%
Longitudinal slope	1.00%
Permeability of drainage material	2,200 ft/day
Effective Porosity	0.3
Infiltration Coefficient	0.5

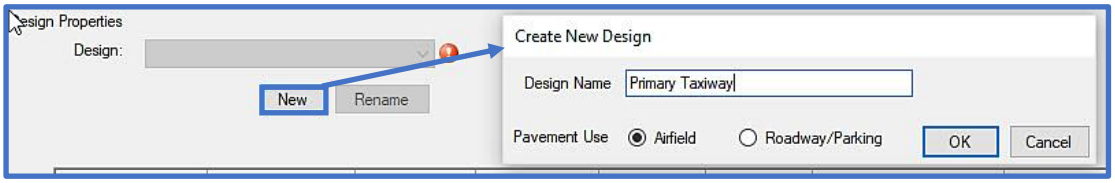


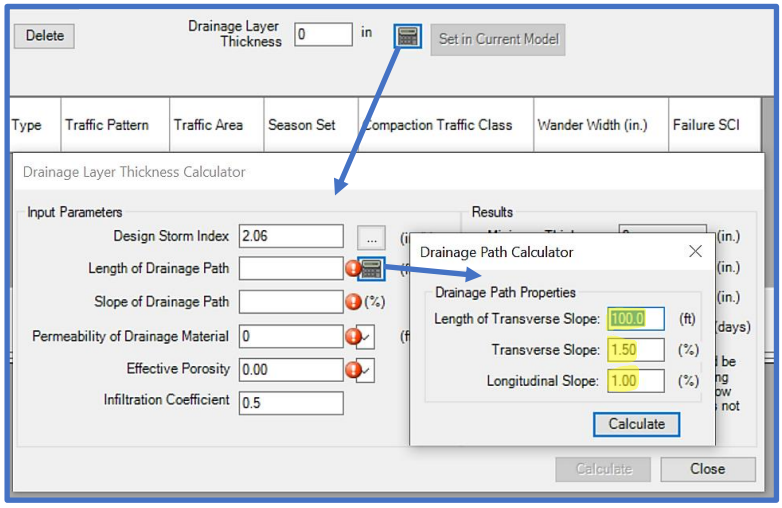


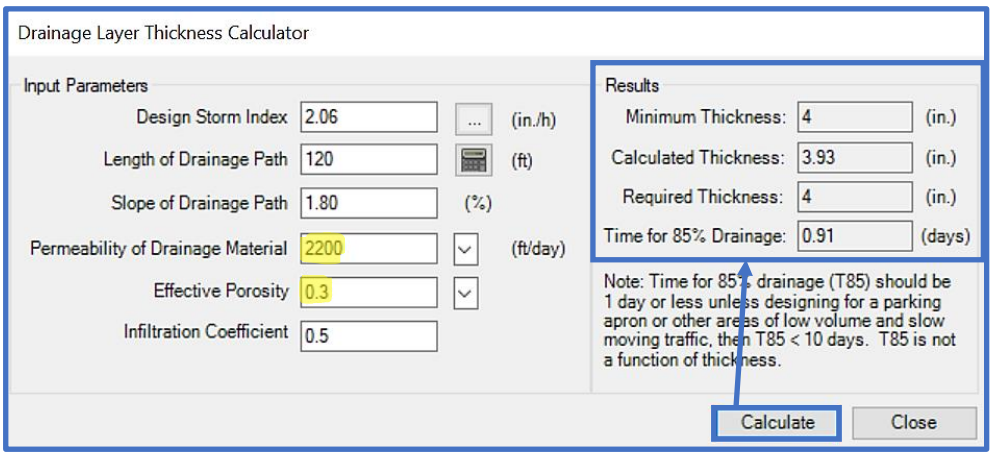


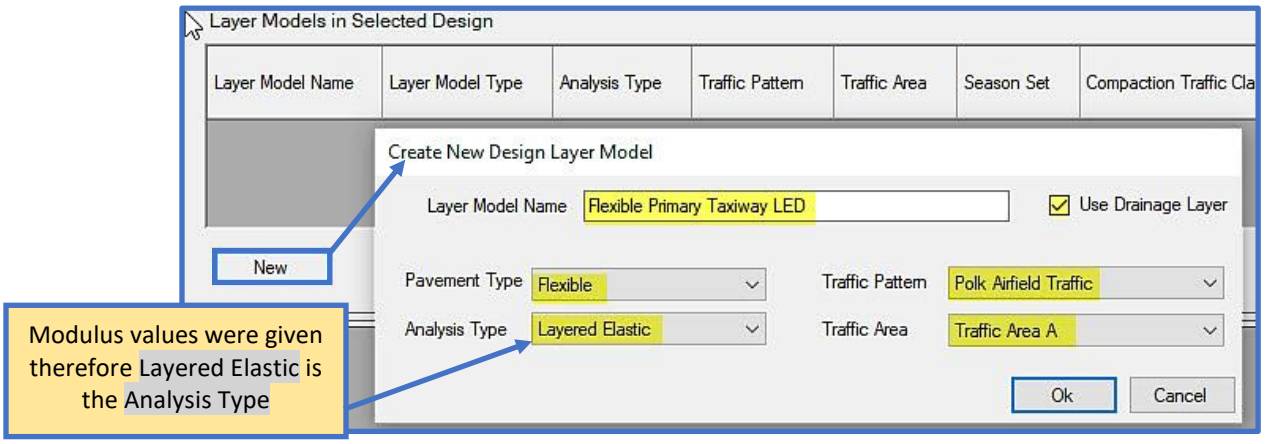


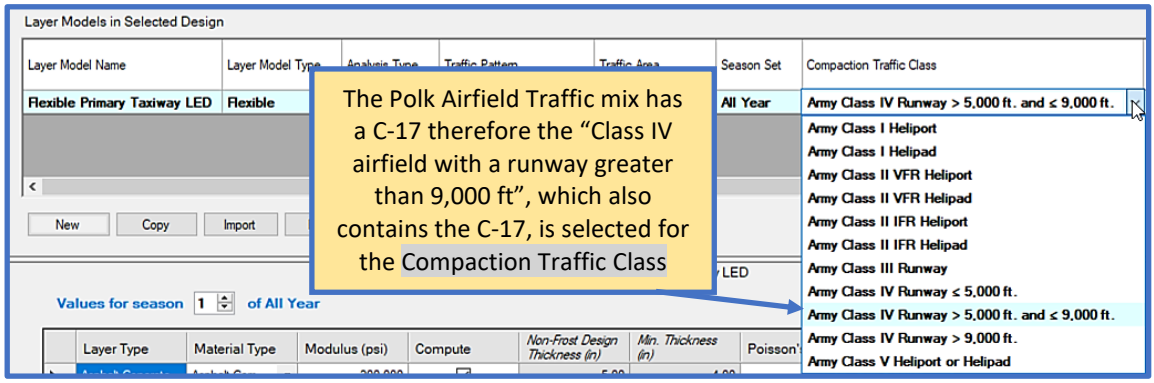
Traffic	Load (lb)		Passes	
	Areas A, B	Areas C, D	Areas A, B, C	Area D
C-17A GLOBEMASTER III	585,000	438,751	5,500	55
C-130H	155,000	116,250	10,500	105
F-15E EAGLE	81,000	60,751	29,000	290


esign Properties
Design:
New
Rename
Create New Design
Design Name
Primary Taxiway
Pavement Use
Airfield
Roadway/Parking
OK
Cancel

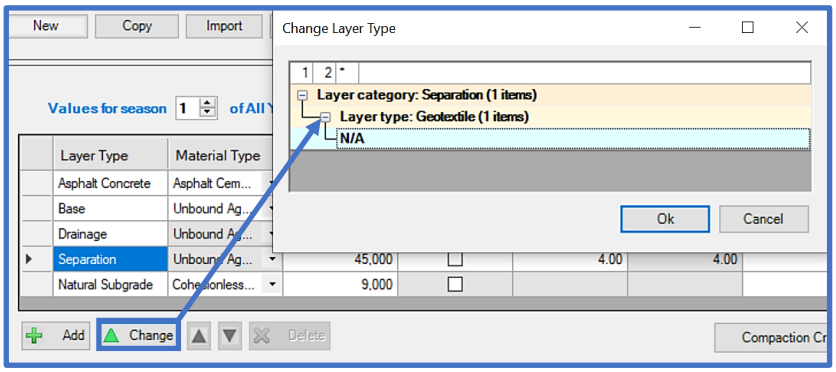

Delete
Drainage Layer Thickness
0
in
Set in Current Model
Type
Traffic Pattern
Traffic Area
Season Set
Compaction Traffic Class
Wander Width (in.)
Failure SCI
Drainage Layer Thickness Calculator
Input Parameters
Design Storm Index
2.06
Length of Drainage Path
Slope of Drainage Path
(%)
Permeability of Drainage Material
0
Effective Porosity
0.00
Infiltration Coefficient
0.5
Results
Drainage Path Calculator
Drainage Path Properties
Length of Transverse Slope:
100.0
(ft)
Transverse Slope:
1.50
(%)
Longitudinal Slope:
1.00
(%)
Calculate
Calculate
Close

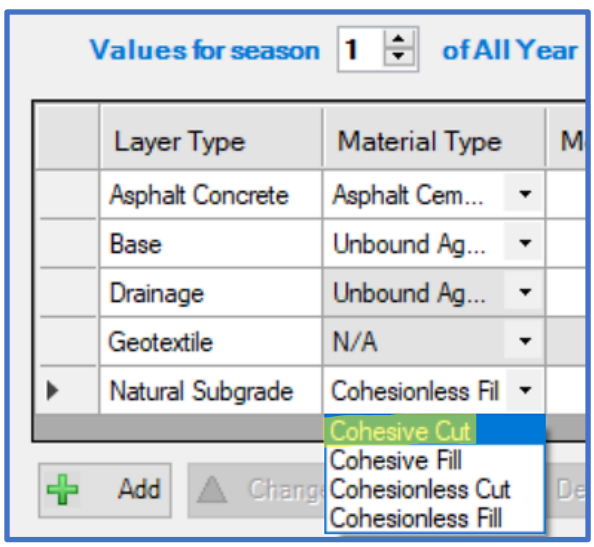

Drainage Layer Thickness Calculator
Input Parameters
Design Storm Index
2.06
(in./h)
Length of Drainage Path
120
(ft)
Slope of Drainage Path
1.80
(%)
Permeability of Drainage Material
2200
(ft/day)
Effective Porosity
0.3
Infiltration Coefficient
0.5
Results
Minimum Thickness:
4
(in.)
Calculated Thickness:
3.93
(in.)
Required Thickness:
4
(in.)
Time for 85% Drainage:
0.91
(days)
Note: Time for 85% drainage (T85) should be 1 day or less unless designing for a parking apron or other areas of low volume and slow moving traffic, then T85 < 10 days. T85 is not a function of thickness.
Calculate
Close


Layer Models in Selected Design
Layer Model Name
Layer Model Type
Analysis Type
Traffic Pattern
Traffic Area
Season Set
Compaction Traffic Cla
New
Create New Design Layer Model
Layer Model Name
Flexible Primary Taxiway LED
Use Drainage Layer
Pavement Type
Flexible
Traffic Pattern
Polk Airfield Traffic
Analysis Type
Layered Elastic
Traffic Area
Traffic Area A
Ok
Cancel
Modulus values were given therefore Layered Elastic is the Analysis Type

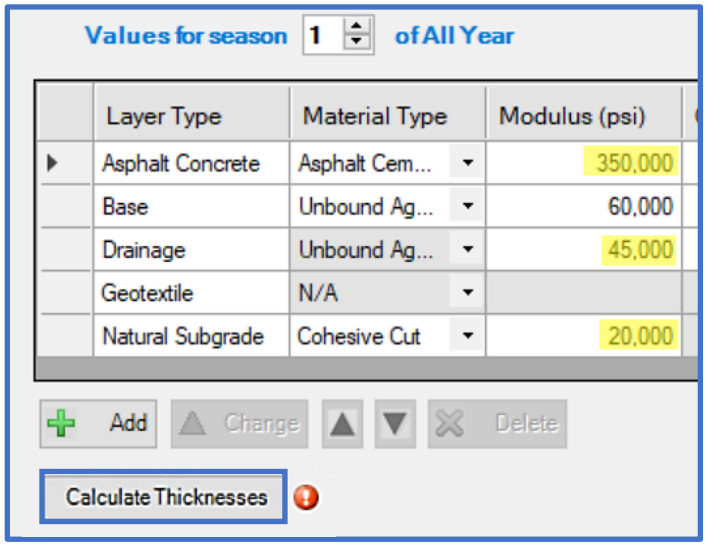


The Polk Airfield Traffic mix has a C-17 therefore the "Class IV airfield with a runway greater than 9,000 ft", which also contains the C-17, is selected for the Compaction Traffic Class





Change the values with the yellow highlight to the given design parameters and Calculate Thicknesses



Design Properties

Design: Primary Taxiway

New | Copy | Rename | Delete

Pavement Use: Airfield

Drainage Layer Thickness: 4 in

Set in Current Model

Layer Models in Selected Design

Layer Model Name	Layer Model Type	Analysis Type	Traffic Pattern	Traffic Area	Season Set	Compaction Traffic Class	Wander Width (in.)	Failure SCI
Flexible Primary Taxiway LED	**Flexible**	**LED**	**Polk Airfield Traffic**	**Traffic Area A**	**All Year**	**Army Class IV Runway > 5,000 ft. and ≤ 9,000 ft.**	70.00	**50**

New | Copy | Import | Delete

Layers in Flexible Primary Taxiway LED

Values for season 1 of All Year

Layer Type	Material Type	Modulus (psi)	Compute	*Non-Frost Design Thickness (in)*	*Min. Thickness (in)*	Poisson's Ratio	Bond
Asphalt Concrete	Asphalt Cem...	350,000	☑	5.00	5.00	0.35	Fully Bonded
Base	Unbound Ag...	60,000	☑	8.91	6.00	0.35	Fully Bonded
Drainage	Unbound Ag...	45,000	☐	4.00	4.00	0.35	Fully Bonded
Geotextile	N/A		☐				
Natural Subgrade	Cohesive Cut	20,000	☐			0.40	

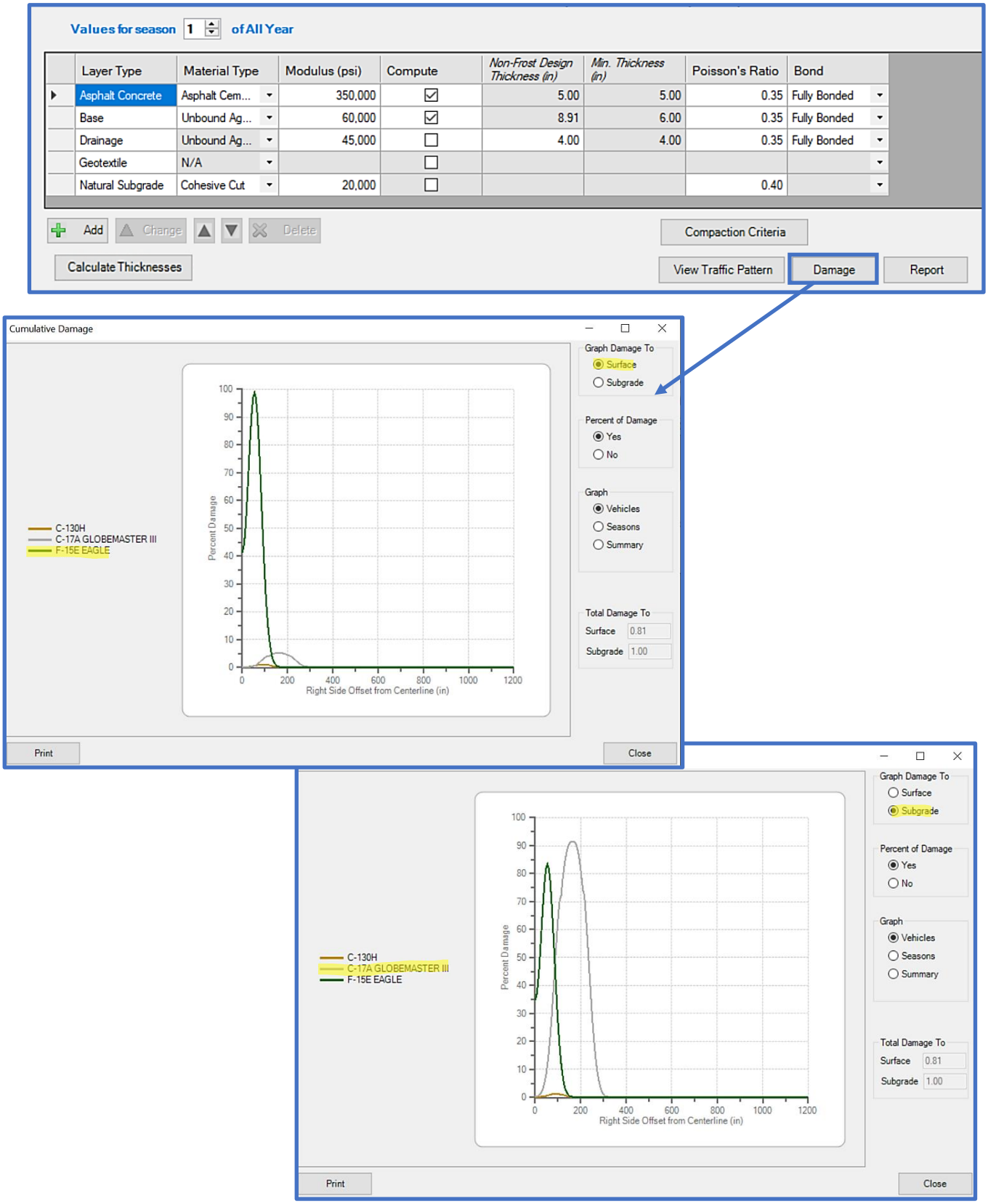
Add | Change | Delete

Compaction Criteria

Airfield Flexible Compaction Requirements

Flexible - Air Force - Cohesive materal (PI > 5; LL > 25)
Flexible - Air Force - Cohesionless material (LL ≤ 25 | PI ≤ 5)
Flexible - Army - Cohesive materal (PI > 5; LL > 25)
Flexible - Army - Cohesionless material (LL ≤ 25 | PI ≤ 5)
Flexible - Navy and Marine Corp

Airfield Type	85 Percent			90 Percent			95 Percent			100 Percent		
	A	B	C	A	B	C	A	B	C	A	B	C
Class I												
Heliport	--	14	--	--	11	--	--	8	--	--	5	--
Helipad	--	13	--	--	10	--	--	7	--	--	5	--
Class II												
VFR Heliport	--	24	--	--	19	--	--	13	--	--	7	--
VFR Helipad	--	22	--	--	17	--	--	12	--	--	7	--
IFR Heliport	--	25	--	--	20	--	--	14	--	--	8	--
IFR Helipad	--	23	--	--	18	--	--	12	--	--	7	--
Class III												
Runway	17	16	13	13	12	10	10	9	7	6	5	4
Class IV												
Runway ≤ 5,000 ft	40	38	32	30	28	24	21	20	16	11	11	8
Runway > 5,000 ft ≤ 9,000 ft	57	55	46	43	41	33	29	27	22	16	16	12
Runway > 9,000 ft	59	57	47	44	42	34	29	28	23	17	16	13
Class V												
Heliport or Helipad	--	20	--	--	16	--	--	11	--	--	6	--
Conversion Factor: Millimeters = 25.4 x inches, Meters = 0.3048 x feet												

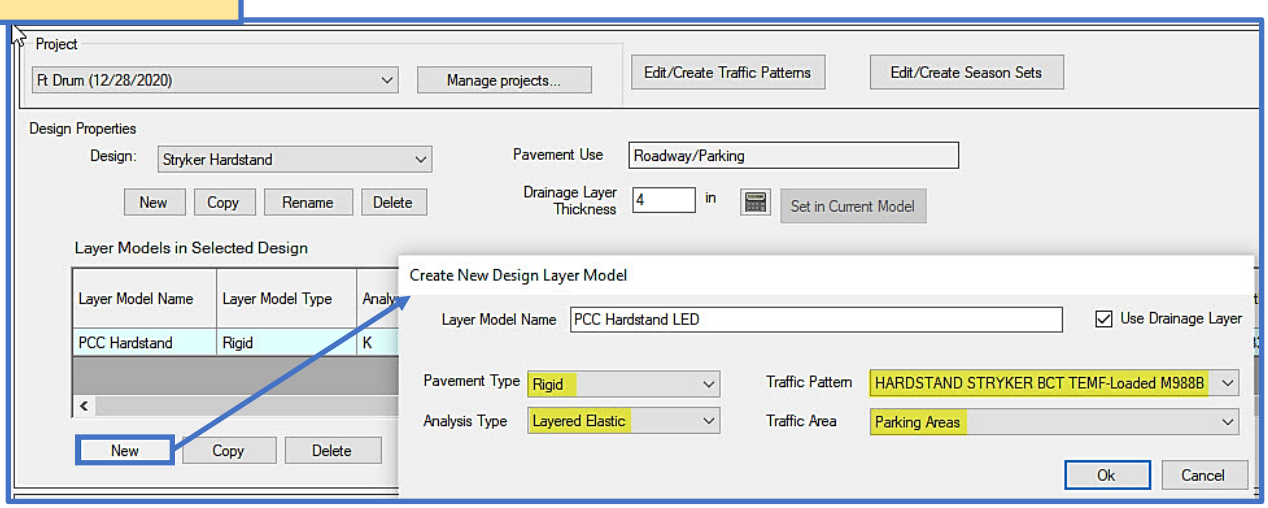

Values for season 1 of All Year
Layer Type | Material Type | Modulus (psi) | Compute | Non-Frost Design Thickness (in) | Min. Thickness (in) | Poisson's Ratio | Bond
Asphalt Concrete | Asphalt Cem... | 350,000 | 5.00 | 5.00 | 0.35 | Fully Bonded
Base | Unbound Ag... | 60,000 | 8.91 | 6.00 | 0.35 | Fully Bonded
Drainage | Unbound Ag... | 45,000 | 4.00 | 4.00 | 0.35 | Fully Bonded
Geotextile | N/A
Natural Subgrade | Cohesive Cut | 20,000 | 0.40
Add
Change
Delete
Compaction Criteria
Calculate Thicknesses
View Traffic Pattern
Damage
Report
Cumulative Damage
Graph Damage To
Surface
Subgrade
Percent of Damage
Yes
No
Graph
Vehicles
Seasons
Summary
Total Damage To
Surface 0.81
Subgrade 1.00
C-130H
C-17A GLOBEMASTER III
F-15E EAGLE
Percent Damage
Right Side Offset from Centerline (in)
Print
Close

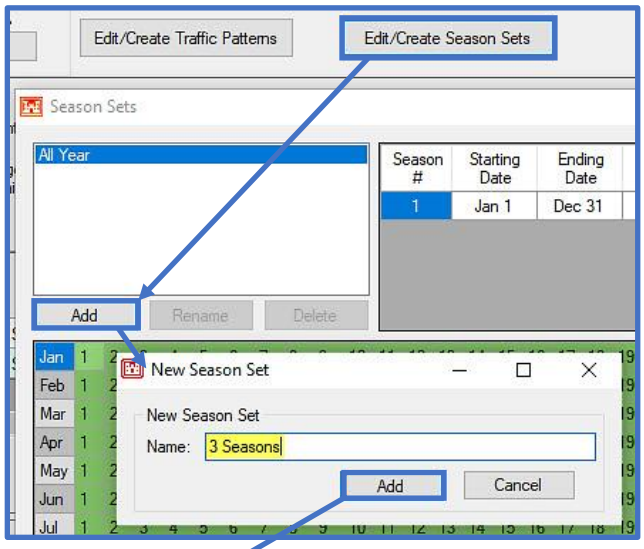
11.5.9 Rigid surfaced parking area using Layered Elastic Design; multiple seasons

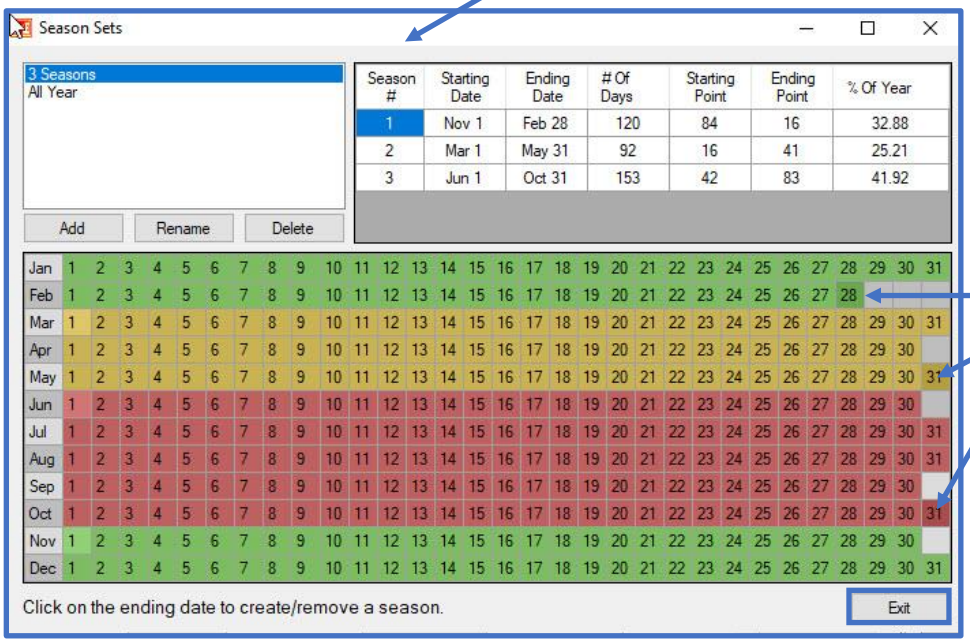
Design a rigid hardstand pavement for a Stryker Brigade Combat Team (BCT) Tactical Equipment Maintenance Facility (TEMF) at the Army reservation, Fort Drum, New York. Use the standard traffic pattern for this hardstand but change the M988B to the Loaded version (see Example 11.5.5). Design the rigid pavement with a flexural strength of 650 psi and the 4.0-inch drainage layer with a 4-inch aggregate separation layer. Since frost penetration is a concern, create multiple seasons and enter the modulus values and Poisson's Ratio given in the table below for each season to account for freezing and thawing conditions.

Material	Season 1		Season 2		Season 3	
	Nov – Feb		Mar – May		Jun - Oct	
	E (psi)	v	E (psi)	v	E (psi)	v
PCC	4,000,000	0.15	4,000,000	0.15	4,000,000	0.15
Drainage	45,000	0.35	45,000	0.35	45,000	0.35
Separation	45,000	0.35	45,000	0.35	45,000	0.35
Subgrade	25,000	0.40	8,000	0.40	16,100	0.40

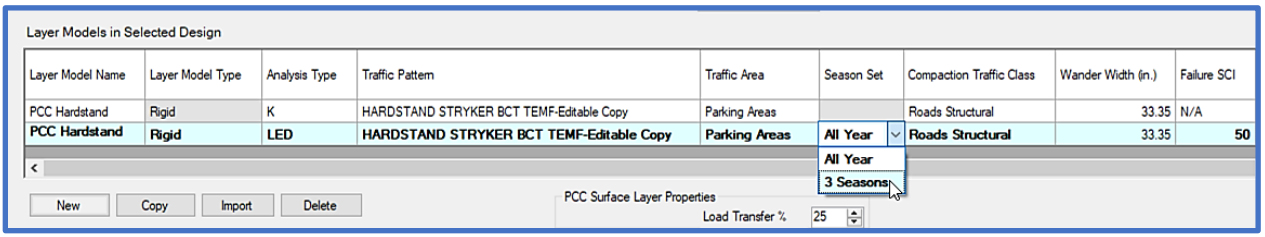
Refer to Example 11.5.5 for project traffic and design properties







For this example, click the last day of the month for each season indicated in the table above



For each season, enter the appropriate Modulus values

Layers in PCC Hardstand LED

Values for season 1 of 3 Seasons

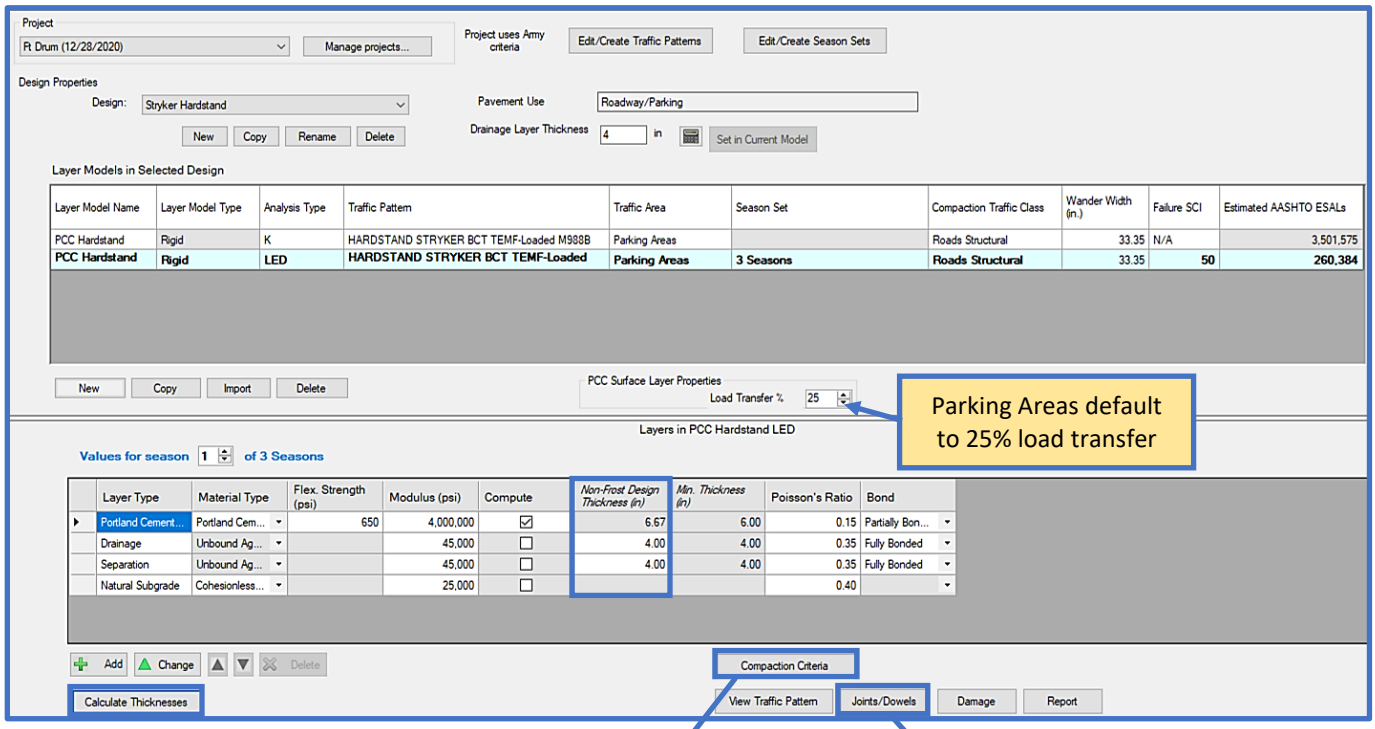
	Layer Type	Material Type	Flex. Strength (psi)	Modulus (psi)	Compute	*Non-Frost Design Thickness (in)*	*Min. Thickness (in)*	Poisson's Ratio	Bond
	Portland Cement...	Portland Cem...	650	4,000,000	☑	6.00	6.00	0.15	Partially Bon...
	Drainage	Unbound Ag...		45,000	☐	4.00	4.00	0.35	Fully Bonded
	Separation	Unbound Ag...		45,000	☐	4.00	4.00	0.35	Fully Bonded
	Natural Subgrade	Cohesionless...		25,000	☐			0.40	

Values for season 2 of 3 Seasons

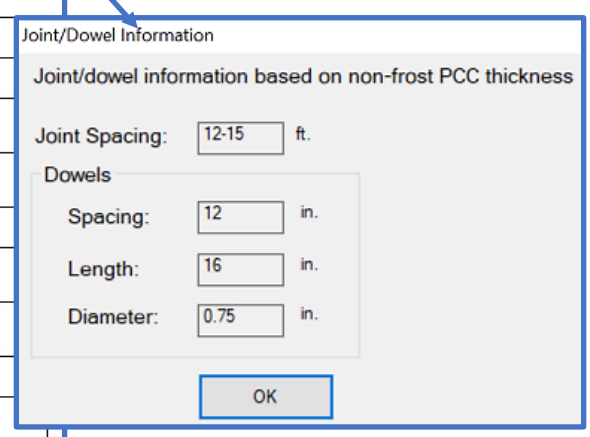
	Layer Type	Material Type	Flex. Strength (psi)	Modulus (psi)
	Portland Cement...	Portland Cem...	650	4,000,000
▶	Drainage	Unbound Ag...		45,000
	Separation	Unbound Ag...		45,000
	Natural Subgrade	Cohesionless...		8,000

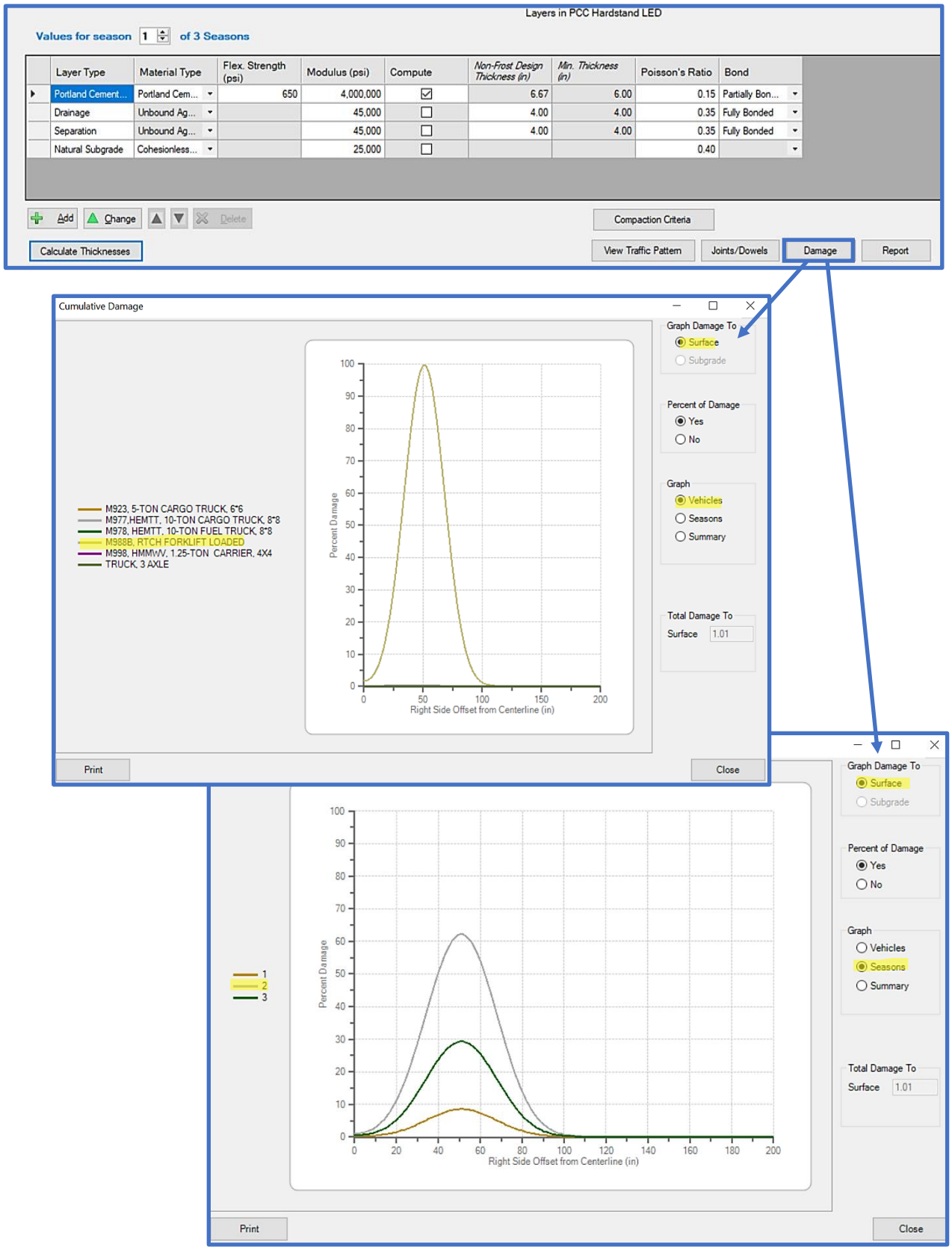
Values for season 3 of 3 Seasons

	Layer Type	Material Type	Flex. Strength (psi)	Modulus (psi)
	Portland Cement...	Portland Cem...	650	4,000,000
▶	Drainage	Unbound Ag...		45,000
	Separation	Unbound Ag...		45,000
	Natural Subgrade	Cohesionless...		16,100



Roadway Compaction Requirements: Rigid Pavements	
Fill Sections	
Cohesive soil (PI > 5; LL > 25)	Full depth of fill - 90% of ASTM D1557 maximum density
Cohesionless soil (PI ≤ 5; LL ≤ 25)	Full depth of fill - 95% of ASTM D1557 maximum density
Cut Sections	
Cohesive soil (PI > 5; LL > 25)	Top 6 inches - 90% of ASTM D1557 maximum density
Cohesionless soil (PI ≤ 5; LL ≤ 25)	Top 6 inches - 95% of ASTM D1557 maximum density
Notes	
Top 6 inches of cuts	May require the subgrade to be scarified and dried or moistened as necessary and re-compacted to the desired density.
If natural subgrade densities ≥ 90% of maximum density	No compaction necessary other than the required to provide a smooth surface.




Layers in PCC Hardstand LED
Values for season 1 of 3 Seasons
Layer Type | Material Type | Flex. Strength (psi) | Modulus (psi) | Compute | Non-Frost Design Thickness (in) | Min. Thickness (in) | Poisson's Ratio | Bond
Portland Cement... | Portland Cem... | 650 | 4,000,000 | ☑ | 6.67 | 6.00 | 0.15 | Partially Bon...
Drainage | Unbound Ag... | | 45,000 | ☐ | 4.00 | 4.00 | 0.35 | Fully Bonded
Separation | Unbound Ag... | | 45,000 | ☐ | 4.00 | 4.00 | 0.35 | Fully Bonded
Natural Subgrade | Cohesionless... | | 25,000 | ☐ | | | 0.40 |
Add
Change
Delete
Compaction Criteria
Calculate Thicknesses
View Traffic Pattern
Joints/Dowels
Damage
Report
Cumulative Damage
M923, 5-TON CARGO TRUCK, 6*6
M977,HEMTT, 10-TON CARGO TRUCK, 8*8
M978, HEMTT, 10-TON FUEL TRUCK, 8*8
M988B, RTCH FORKLIFT LOADED
M998, HMMWV, 1.25-TON CARRIER, 4X4
TRUCK, 3 AXLE
Percent Damage
Right Side Offset from Centerline (in)
Graph Damage To
Surface
Subgrade
Percent of Damage
Yes
No
Graph
Vehicles
Seasons
Summary
Total Damage To
Surface 1.01
Print
Close
1
2
3

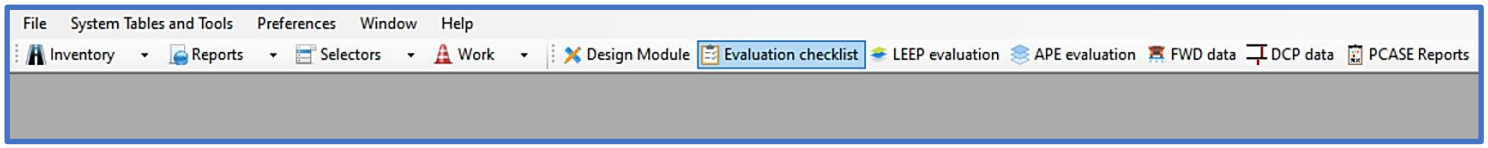
12 Evaluation Checklist

Evaluation checklist displays sections in the selected Evaluation and the APE and LEEP status. Sections can be added, edited and deleted. The checklist also provides access to the Evaluation Manager and Inventory form, allows you to import or export evaluation data, run reports, and works as a selector when an evaluation form is set to Selector Mode.

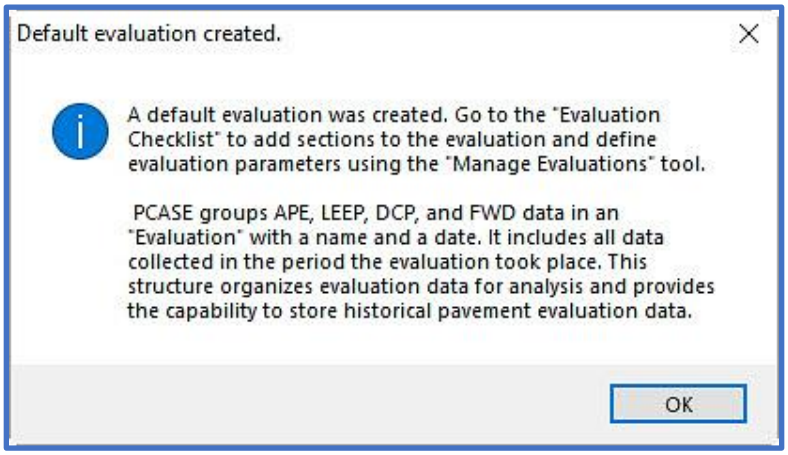
Prior to beginning a new evaluation, ensure that you have opened or created a database to store the evaluation within (database name is displayed on the bottom-left of the main window). For instructions on how to import or create a database; reference Chapter 2 File Menu.

12.1 Getting Started

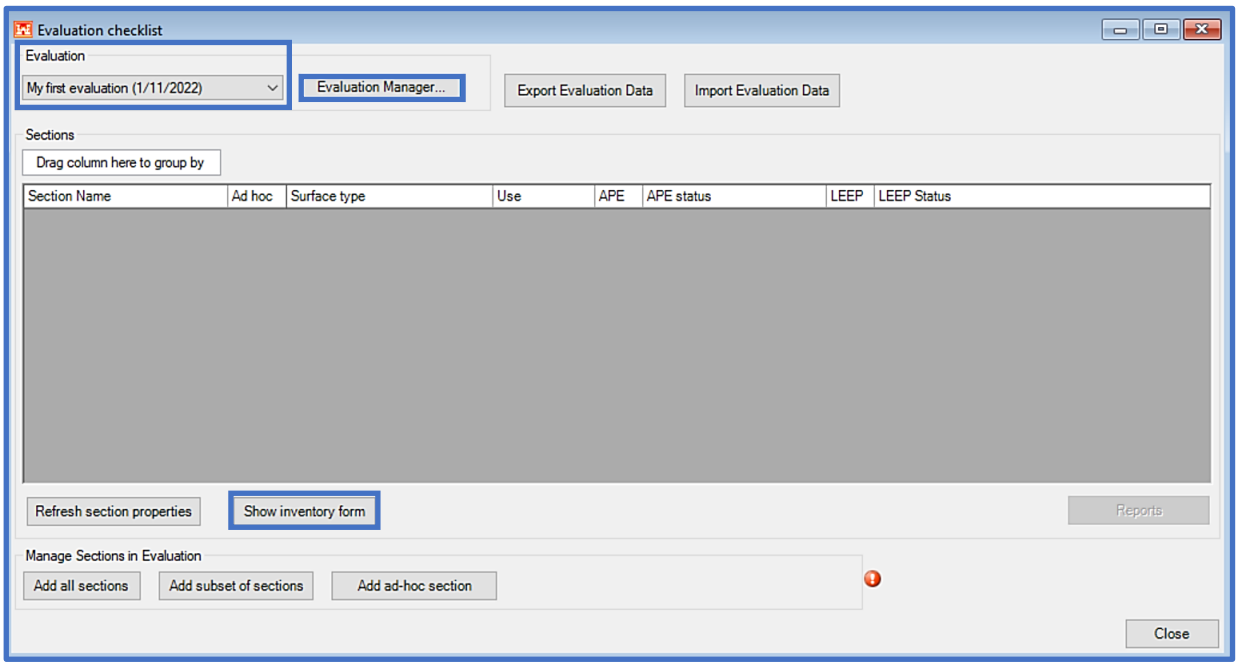
Select Evaluation Checklist on the PCASE 7 tool bar to open the checklist.



If you have not imported or created an evaluation in the current database, the message below pops up indicating a default evaluation was created. Click OK to continue and open the Evaluation checklist.



If you created a new database the checklist will be empty. When the Evaluation checklist opens you can select Evaluation Manager to create a new evaluation or Show inventory form to define an inventory. If previous evaluations were created; the Evaluation drop-list can be used to navigate to the appropriate evaluation.

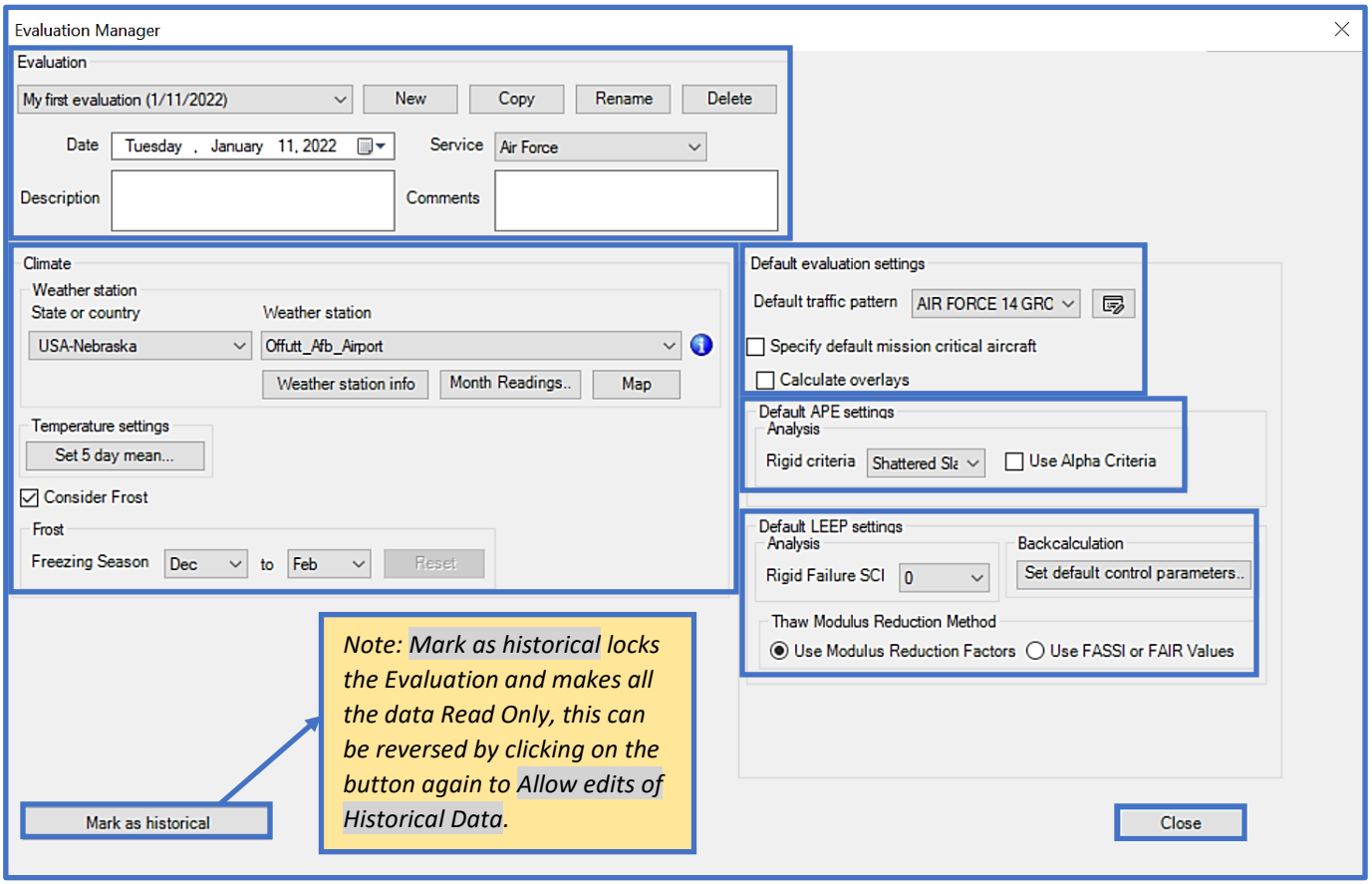


12.2 Show inventory form

Inventory is normally defined prior to using the Evaluation Checklist; however, Show inventory form launches the form and List Selector so that you can define an inventory. If you select Show inventory form; reference Chapter 7.1 Define Inventory for guidance on defining an inventory.

12.3 Evaluation Manager

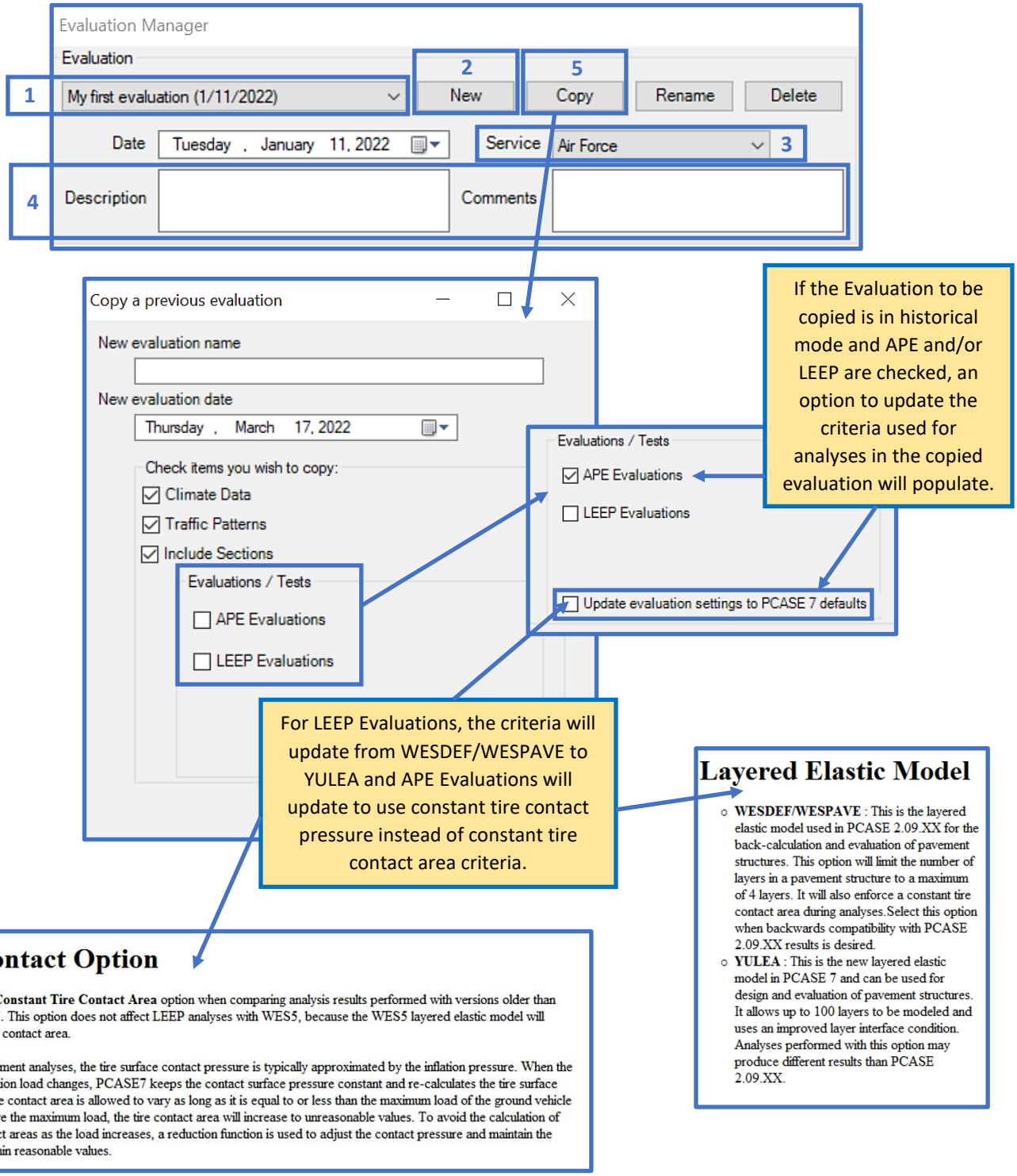
Evaluation Manager serves to establish global analysis parameters and can be accessed from the Evaluation Checklist, LEEP, APE, FWD, or DCP modules. If you have historical evaluation data from an earlier version of PCASE to import, go to Chapter 2.2 New/Import for instructions on how to import a PCASE 2.09 database. Once the import is successful, evaluations from the imported database will be available in the Evaluations drop-list on the Evaluation checklist and Evaluation Manager forms. The Evaluation Manager form is displayed below. You will go through various sub-sections of the form to set up the analysis parameters. The sub-sections are Evaluation, Climate, Default evaluation settings, Default APE settings, and Default LEEP settings. Mark as historical locks the Evaluation and makes all the data read-only, this can be reversed by clicking on the button again to Allow edits of Historical Data. Select Close to exit the Evaluation Manager and return to the Evaluation Checklist.



12.3.1 Evaluation

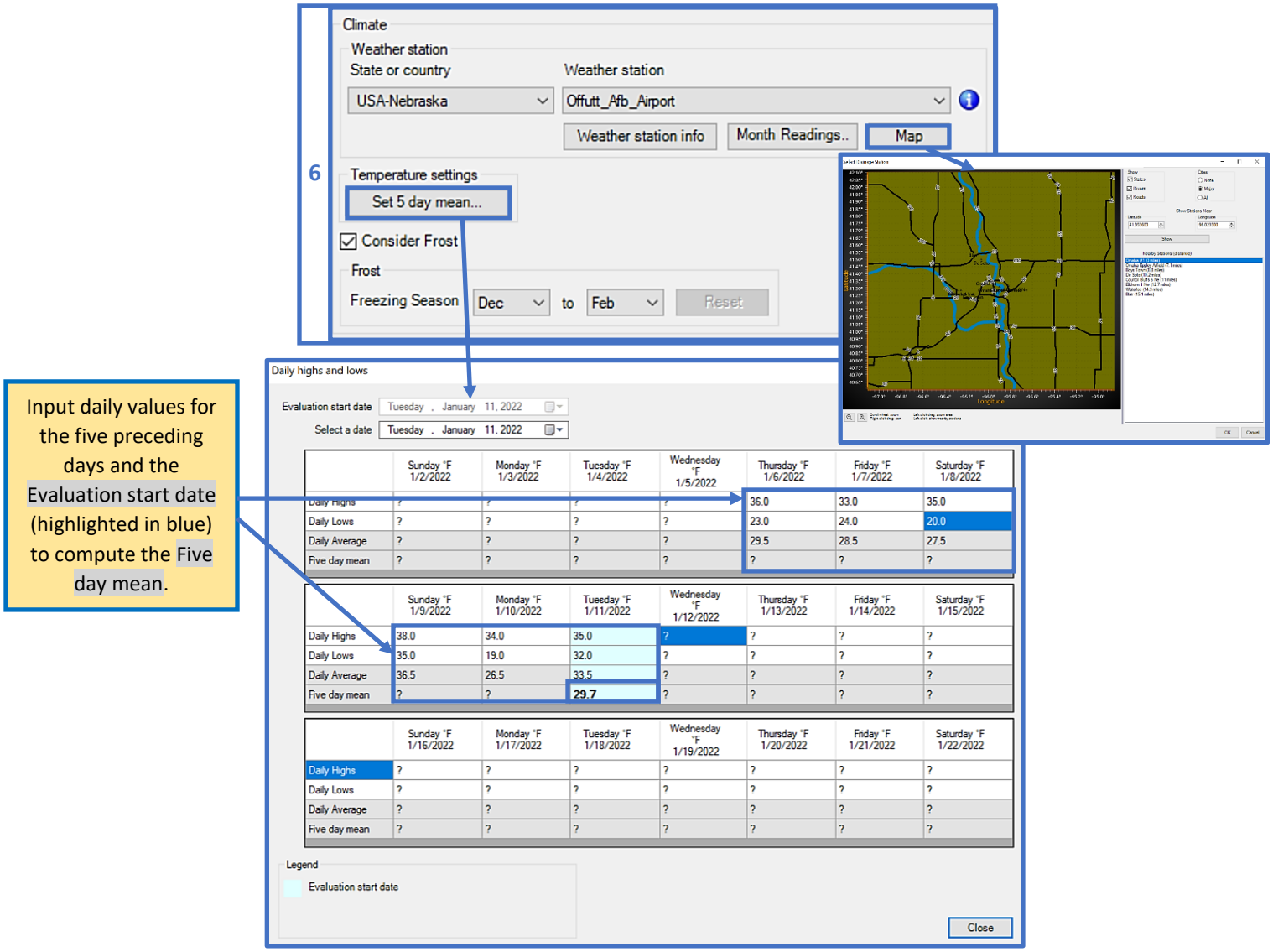
1. Choose an Evaluation from the drop-list, or
2. Click New to create an Evaluation then input an Evaluation name. The Default evaluation date will populate with the current date; select the calendar icon or type in the field to modify the date. Recommend using the first projected day for the start of the evaluation. Select the appropriate radio button to enable/activate sections to include in the Evaluation:
   - Include All Sections (PCASE 209 default behavior): All Sections will be included in the Evaluation. You will still have the ability to choose from these Sections while using the various Evaluation tools.
   - Select sections to include, using the Query Tool, after create: This option opens the Query Tool Wizard where you can define Section criteria. The Tree Selector will highlight Sections from the list by default. Choose a Field in the Select Rows tab, then choose a Comparison. Click Finish (button will enable after selections have been made) to create the subset.
   - Add Sections Later: This option will not bring Section data into the Evaluation; however, the user will have the ability to create ad-hoc Sections while using the various Evaluation tools.
3. Choose the Service from the drop-list that is appropriate for the Evaluation.
4. The next two fields are optional. Add a Description and Comments, if so desired.

5. The Copy function allows you to choose which data to include, then creates a copy of the currently selected Evaluation.



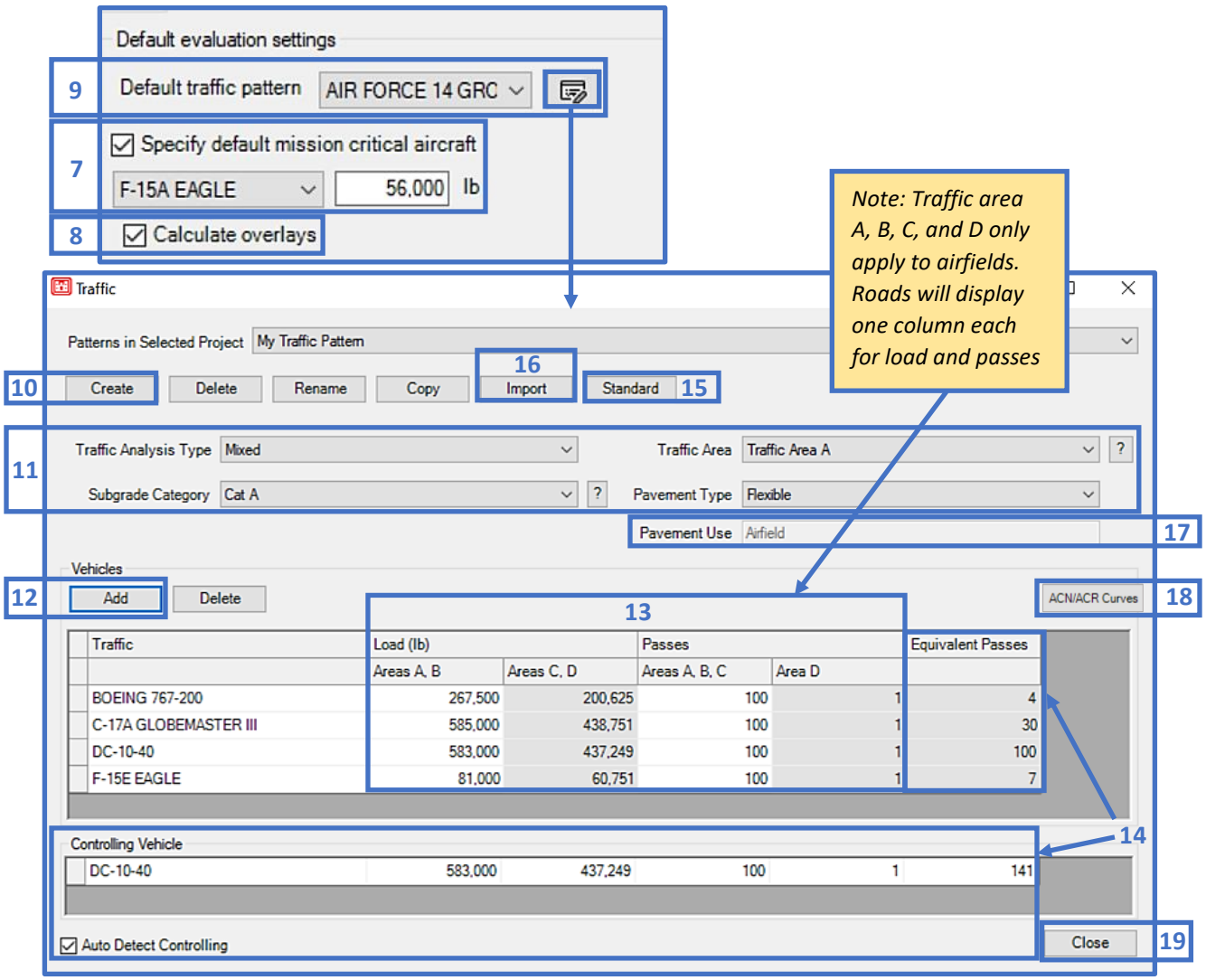
12.3.2 Climate

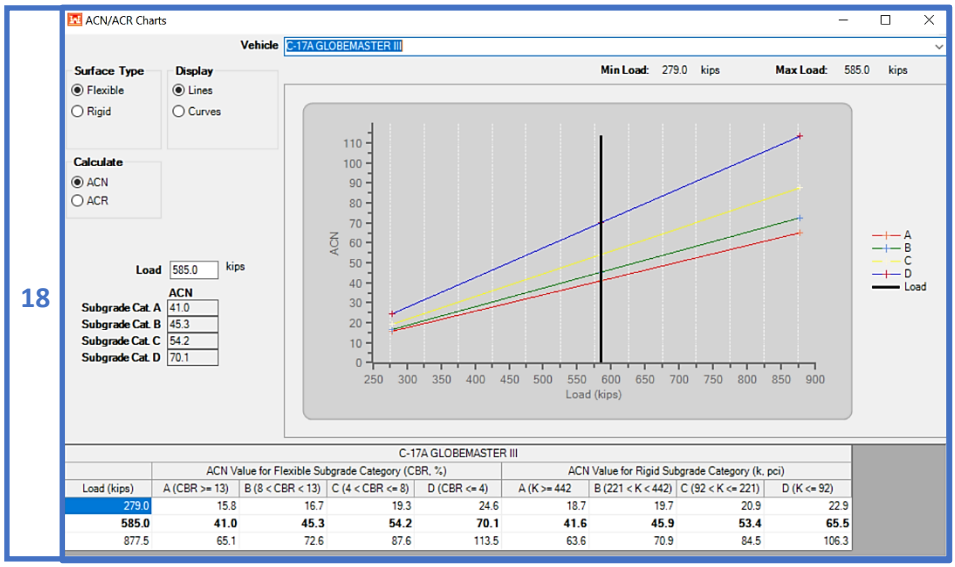
6. Choose the State or country and Weather station you would like to pull climate data from for the Evaluation. Click Map to search for nearby weather stations, select from the Nearby Stations box, then OK. Once a Weather Station has been selected, you can roll over the icon or click on the Weather station info button to view the frost details. Select Month Readings to display the Climate Data Summary: Mean Daily Maximums, Mean, and Mean Daily Minimums for each month (the data populates automatically and should only be edited if you have more detailed information on the location). Set 5 day mean launches a form where you can input daily temperature values to determine the five-day mean (highlighted in blue). Select the Consider Frost checkbox, if applicable. The Freezing Season drop-lists will enable and display the calculated freezing season from the Climate Data Summary. If you choose to edit the default Freezing Season months, the Reset button will enable and allow you to reset changed values back to the original defaults.



12.3.3 Default evaluation settings

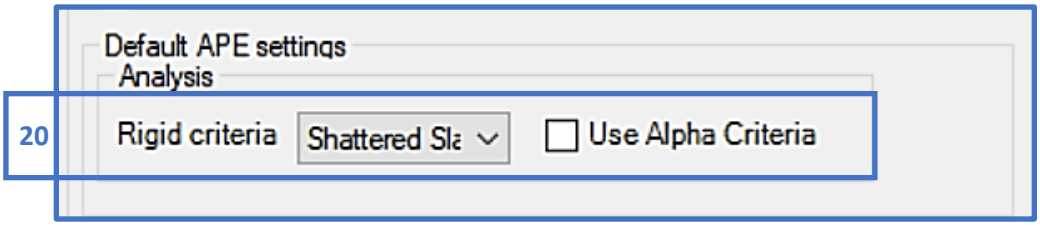
7. Select Specify default mission critical aircraft to set a mission critical vehicle to use in analyses at the Evaluation level. The same function exists within the Traffic tab on the APE and LEEP forms, so that you have the option to override what was set in Evaluation Manager on a section-by-section basis.
8. Select Calculate overlays to enable calculation of overlay thicknesses (applicable for both flexible and rigid pavements) when executing APE or LEEP evaluation analyses.
9. If a database has been imported, the existing traffic patterns for the Evaluation will be available in the Default traffic pattern drop-list. To define or select a Default traffic pattern, select the icon. *Note: Newly created Evaluations will inherit the Default traffic pattern that is set in PCASE Defaults > Evaluation Defaults.*
10. To define a new traffic pattern with specific vehicles, select Create. Enter a unique Pattern Name, select a Pavement Use, then click OK.
11. Choose the appropriate Traffic Analysis Type (Individual to analyze each vehicle in the pattern or Mixed to determine the Controlling Vehicle). If you selected Mixed; drop-list fields for Subgrade Category, Traffic Area, and Pavement Type will populate for you to define.
12. Click Add to select vehicles for a newly created pattern from the Choose Vehicles form. An Air, Ground, or Both vehicle filter is available to help you narrow selections. Click on a box to the left of a vehicle name, or on the vehicle name to select it. Click OK to assign the selected vehicles to the pattern.
13. The default values for Load and Passes can be edited within the grid cells, unless cells are colored gray (which signifies the pattern is set to read-only).
14. If Traffic Analysis Type Mixed is selected; the Equivalent Passes for each vehicle and the Controlling Vehicle will be displayed in the grids. The Equivalent Passes are sensitive to the defined Traffic Area, Subgrade Category, and Pavement Type. If you'd like to set a different vehicle as controlling, uncheck Auto Detect Controlling and choose the vehicle from the drop-list to set as controlling.
15. Choose Standard to select from Tri-Service, pre-defined traffic patterns. Click on a box to the left of a standard pattern name or on the name to select it. Choose to save the pattern as Traffic Read-only (default) or Make a Read/Write Copy (editable). Click OK to assign the selected pattern.
16. Choose Import to select an existing traffic pattern. The Source Database drop-list contains all of the databases in your user data folder, select the database that has the traffic pattern(s) you would like to import. Once the appropriate database has been selected, choose an Evaluation from the Source Project drop-list to display the traffic patterns you can select for import. Click Ok to import selected traffic pattern(s).
17. The Pavement Use, related to the pattern is displayed.
18. Select ACN/ACR Curves to view the Aircraft Classification Number (ACN) and Aircraft Classification Rating (ACR) curves. See an example of the chart form on the following page.
19. Click Close to exit the Traffic form and return to the Evaluation Manager.


Default evaluation settings
9
Default traffic pattern
AIR FORCE 14 GRC
7
Specify default mission critical aircraft
F-15A EAGLE
56,000
lb
8
Calculate overlays
Note: Traffic area A, B, C, and D only apply to airfields. Roads will display one column each for load and passes
Traffic
Patterns in Selected Project
My Traffic Pattern
10
Create
Delete
Rename
Copy
16
Import
Standard
15
11
Traffic Analysis Type
Mixed
Traffic Area
Traffic Area A
Subgrade Category
Cat A
Pavement Type
Flexible
Pavement Use
Airfield
17
Vehicles
12
Add
Delete
13
ACN/ACR Curves
18
Traffic
Load (lb)
Passes
Equivalent Passes
Areas A, B
Areas C, D
Areas A, B, C
Area D
BOEING 767-200 267,500 200,625 100 1 4
C-17A GLOBEMASTER III 585,000 438,751 100 1 30
DC-10-40 583,000 437,249 100 1 100
F-15E EAGLE 81,000 60,751 100 1 7
Controlling Vehicle
DC-10-40 583,000 437,249 100 1 141
14
Auto Detect Controlling
Close
19


18
ACN/ACR Charts
Vehicle
C-17A GLOBEMASTER III
Surface Type
Flexible
Rigid
Display
Lines
Curves
Calculate
ACN
ACR
Min Load: 279.0 kips
Max Load: 585.0 kips
Load 585.0 kips
ACN
Subgrade Cat. A 41.0
Subgrade Cat. B 45.3
Subgrade Cat. C 54.2
Subgrade Cat. D 70.1
ACN
Load (kips)
A
B
C
D
Load
C-17A GLOBEMASTER III
ACN Value for Flexible Subgrade Category (CBR, %)
ACN Value for Rigid Subgrade Category (k, pci)
Load (kips) | A (CBR >= 13) | B (8 < CBR < 13) | C (4 < CBR <= 8) | D (CBR <= 4) | A (K >= 442 | B (221 < K < 442) | C (92 < K <= 221) | D (K <= 92)
279.0 15.8 16.7 19.3 24.6 18.7 19.7 20.9 22.9
585.0 41.0 45.3 54.2 70.1 41.6 45.9 53.4 65.5
877.5 65.1 72.6 87.6 113.5 63.6 70.9 84.5 106.3

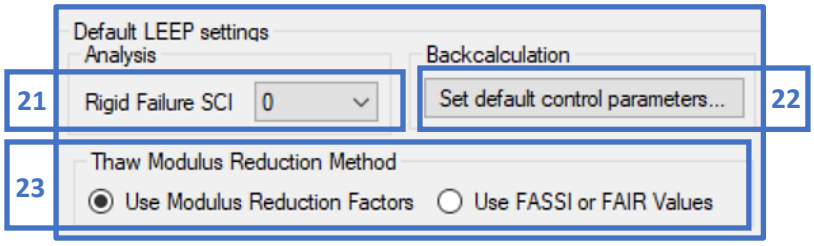
12.3.4 Default APE settings

20. Set the default Rigid criteria for a APE Evaluation of a rigid pavement. The APE Rigid criteria options are: First Crack, Shattered Slab, or Complete Failure. The default criteria for each Service will populate when the Service is changed. Select the checkbox for Use Alpha Criteria to use PCASE 2.09.02 analysis criteria for flexible pavement analyses.



12.3.5 Default LEEP settings

21. Select the default Rigid Failure SCI for a LEEP Evaluation of a rigid pavement. The LEEP Rigid Failure SCI options are: 0, 50, and 80. The Rigid Failure SCI value will update with the appropriate default value when the Service is changed within the form.
22. Set default control parameters form is applicable to the LEEP Modulus Backcalculation procedure.
23. Define the Thaw Modulus Reduction Method you would like to use for LEEP Evaluations. This setting can be overridden for specific sections in the Evaluation within the Analysis tab on the LEEP form.

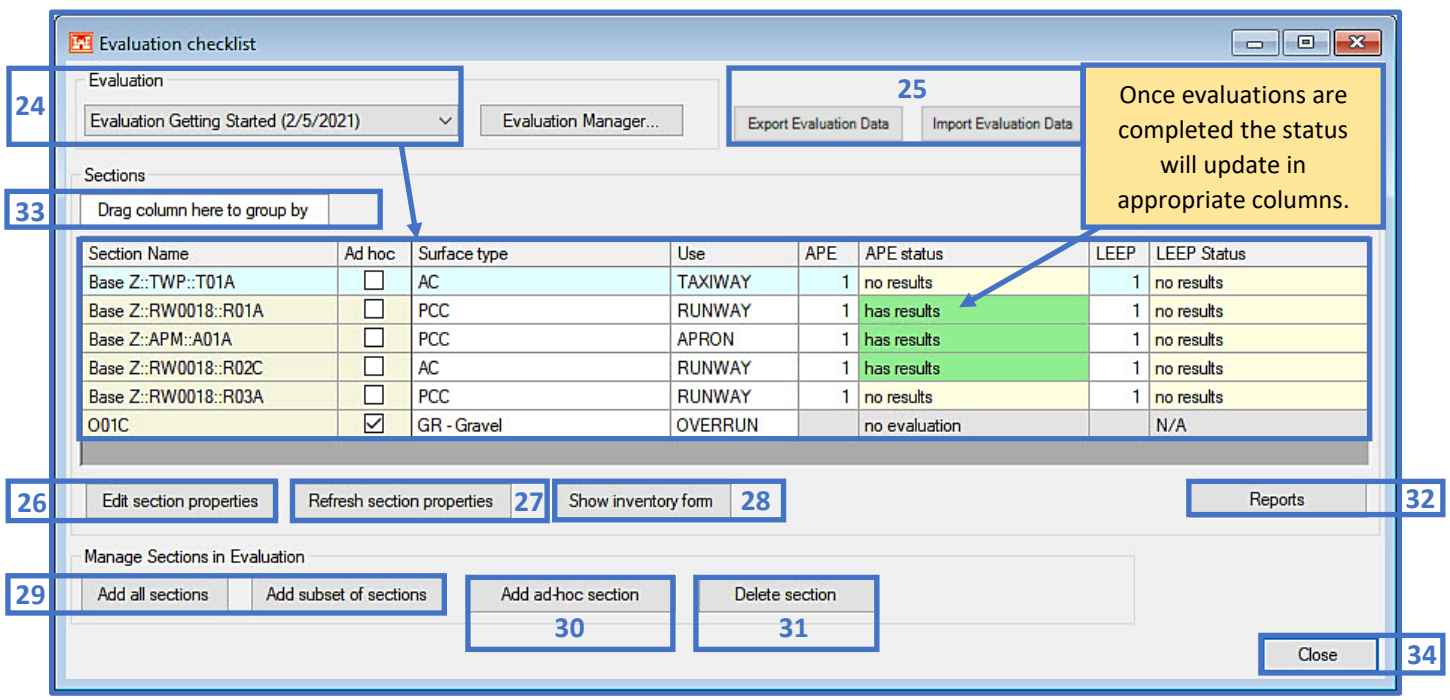


12.4 Evaluation checklist

To navigate the Evaluation checklist:

24. Ensure the correct Evaluation is selected in the drop-list field. Section data displays in the grid if PCASE data was imported (reference Chapter 2 File Menu) or an inventory has been pre-defined (reference Chapter 7.1 Define Inventory) in the current database.
25. The Export Evaluation Data and Import Evaluation Data functions provide a simple method for sharing updated Evaluation data when working with multiple teams. Selecting either option launches File Explorer so you can choose the evaluation file to import or export into the current database.

26. Select Edit section properties to:
    a. Input the PCI and % Load-related Distress values for calculating the condition factors (C_b, C_r) for rigid overlays
    b. Change the Traffic area and/or Load frequency values.
    c. Select Evidence of Frost Damage if applicable.
27. Select Refresh section properties to update the section properties from the pavement inventory.
28. Select Show inventory form to open the inventory form.
29. To manage which Sections are included in the selected Evaluation, select Add all sections or Add subset of sections. Add subset of sections opens a query tool for selecting the Sections to add; this is recommended if there are multiple Evaluations within a database.
30. Select Add ad-hoc section to create an "ad-hoc" Section (a Section created on the fly that is not included in the defined inventory).
31. To delete a Section, highlight the Section and click Delete section.
32. Select Reports to access the predefined Evaluation reports window. See Chapter 17 Reports for more information. *Note: PCASE reports use Excel templates without any classification markings based on the assumption that all data is unclassified and publicly releasable. If the information in the individual database is Controlled Unclassified Information (CUI), properly mark any reports generated by PCASE at the appropriate classification level. Add a header and footer with the appropriate classification markings.*
33. Click on a column header and drag it to the Drag column here to group by box to sort grid data by the selected header.
34. Click Close to exit the Evaluation checklist.



13 LEEP Evaluation

LEEP evaluation is capable of analyzing pavements using the layered elastic method producing resultant allowable loads, passes, Pavement Classification Numbers (PCN), and overlay requirements.

Prior to beginning a new evaluation, ensure that you have opened or created a database to store the evaluation within (database name is displayed on the bottom-left of the main window). For instructions on how to import or create a database; reference Chapter 2 File Menu.

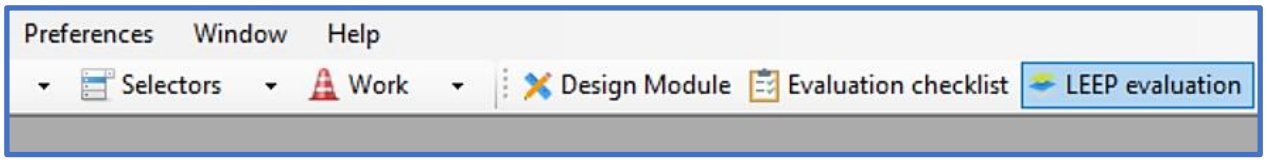
Prior to using LEEP evaluation form, ensure you have defined your inventory (unless you will be creating sections Ad Hoc); reference Chapter 7 Inventory.

The asset inventory should be initialized prior to using the LEEP evaluation form; reference Chapter 12 Evaluation checklist.

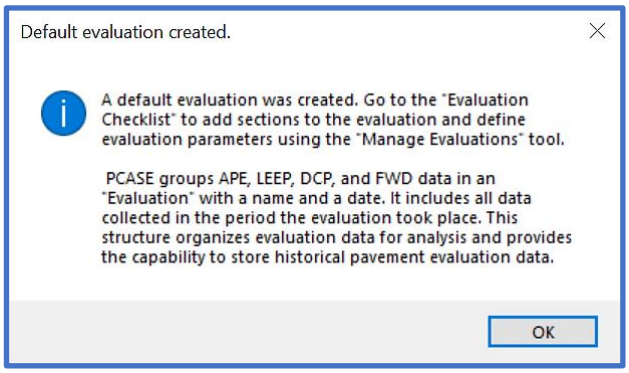
The modulus Backcalculation function within LEEP Evaluation requires uploading FWD/HWD files, data processing, inventory sectioning and subsequent station assignment. For instructions on how to import FWD/HWD data and assign to sections and stations; reference Chapter 15 FWD data.

13.1 Getting Started

To get started, select LEEP evaluation on the PCASE 7 tool bar to open the evaluation tool.

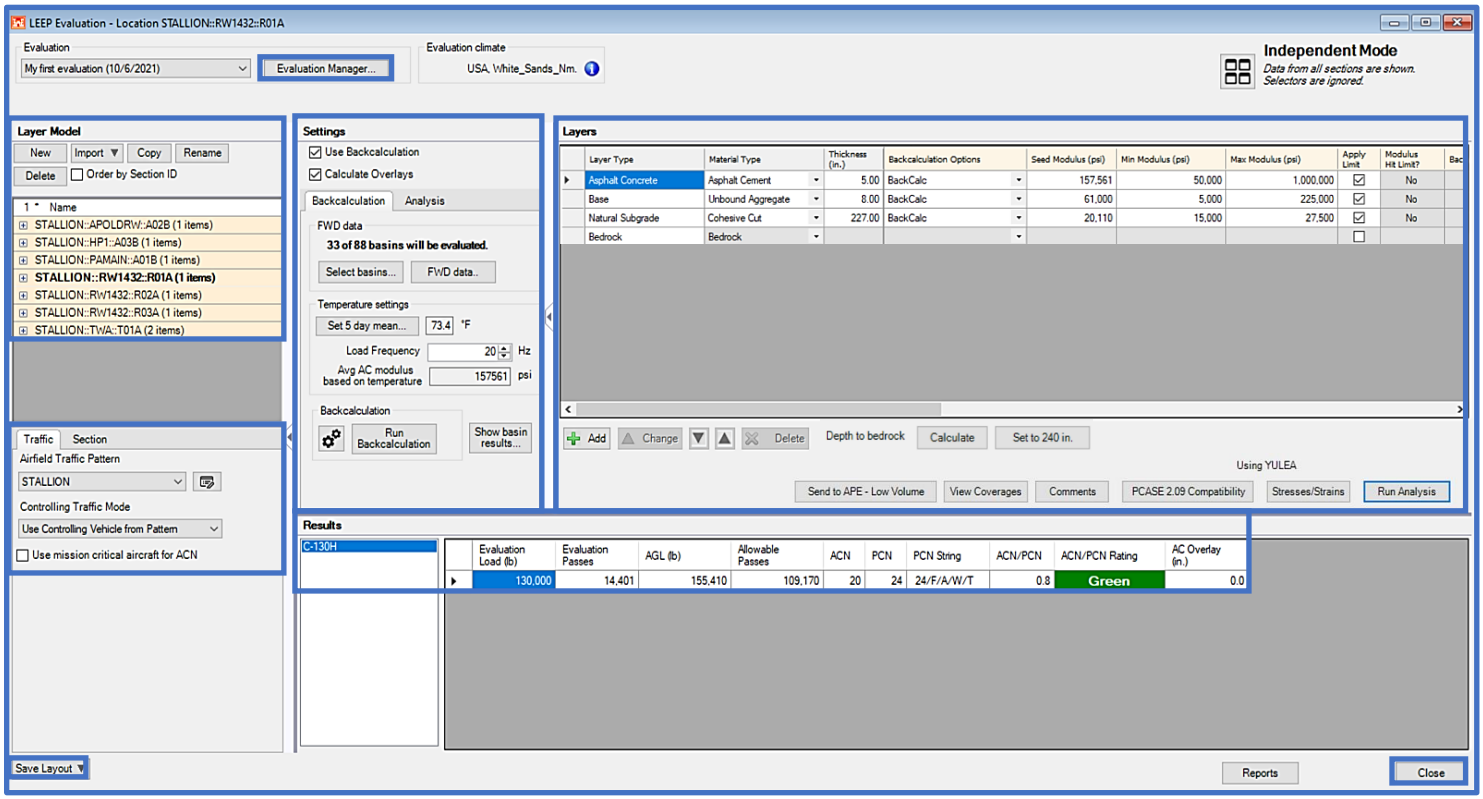


If you have not imported or created an evaluation in the current database, the message below pops up indicating a default evaluation was created. Click OK to continue and open the LEEP evaluation form.



13.2 LEEP Evaluation Form

The LEEP evaluation form (displayed below) serves to perform complete evaluation of airfield and road pavements employing layered elastic procedures. To run a LEEP evaluation, you will go through various sub-sections of the form to modify the default analysis conditions, if desired. The sub-sections are Evaluation Manager, Layer Model, Traffic and Section tabs, Settings, and Layers. The analysis output results are displayed within the Results sections. The Reports button displays when analysis results are present. The panels in the LEEP form are adjustable and you can save a form configuration using the Save Layout function. Select Close to exit LEEP evaluation.

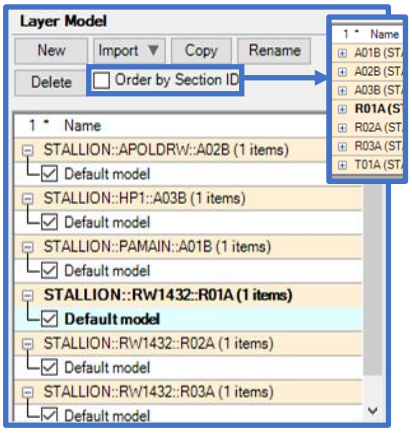


13.2.1 Evaluation Manager

Evaluation Manager serves to establish global analysis parameters. To navigate Evaluation Manager; reference Chapter 12 Evaluation Checklist, Section 12.3 Evaluation Manager.

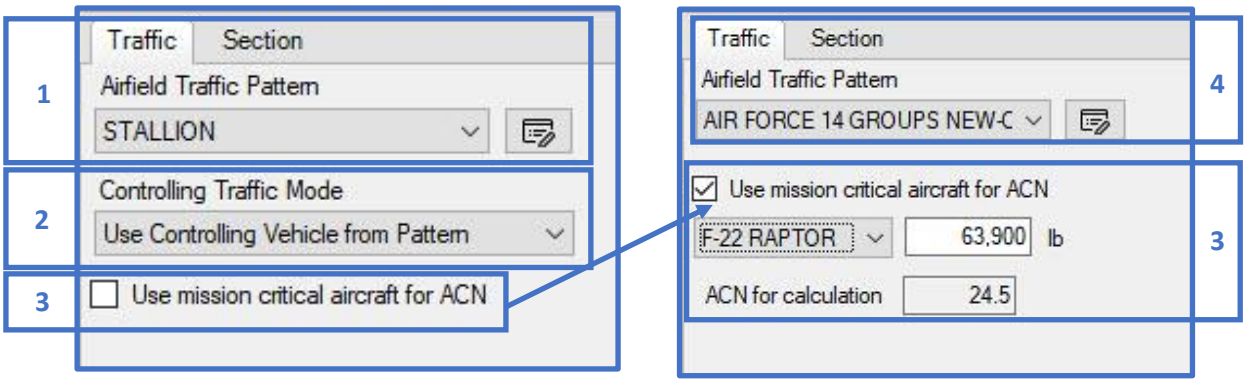
13.2.2 Layer Model

The Layer Model grid lists default pavement structures that may be modified in the Layers grid, to produce analysis results for a Section of a LEEP evaluation in the Results grid. Multiple layer models (each with distinct, user-specified analysis conditions and results) can exist for a given section of an Evaluation. To create a new Layer Model, select New. To import a model from another evaluation, a design, DCP, or APE (from the same evaluation) select Import. The model must be within the currently open database. To copy an existing model and all the associated analysis conditions and results, select a model then select Copy. Select Rename to edit the default Layer Model name. To delete a model replicate, select the model then Delete.



13.2.3 Traffic tab

1. Traffic patterns defined within Evaluation Manager are available for selection in all evaluations. An existing traffic pattern can be selected from the drop-list within the Traffic tab, or a new traffic pattern can be created by selecting the icon, then Create (user-defined traffic) or select a Standard (pre-defined traffic patterns) pattern.
2. If Traffic Analysis Type Mixed is selected, the options for Controlling Traffic Mode are: Use Controlling Vehicle from Pattern, Calculate Controlling Vehicle and Choose Controlling Vehicle. Use Controlling Vehicle from Pattern will utilize the loading and equivalent passes of the Controlling Vehicle defined within the Traffic form. This is based on the Traffic Area, Subgrade Category, and Pavement Type. Calculate Controlling Vehicle will recalculate the loading and equivalent passes of the Controlling Vehicle based on the Traffic Area selected in the Section Properties sub-section, and the Subgrade Category associated with the CBR value of the subgrade within the Layers sub-section. Choose Controlling Vehicle allows you to select which vehicle in the mix controls.
3. In addition to calculating the ACN and PCN for the traffic in the selected pattern, Use mission critical aircraft for ACN allows you to select an additional aircraft for analysis.
4. If an Individual traffic pattern is selected, the options for Controlling Traffic Mode are not displayed.

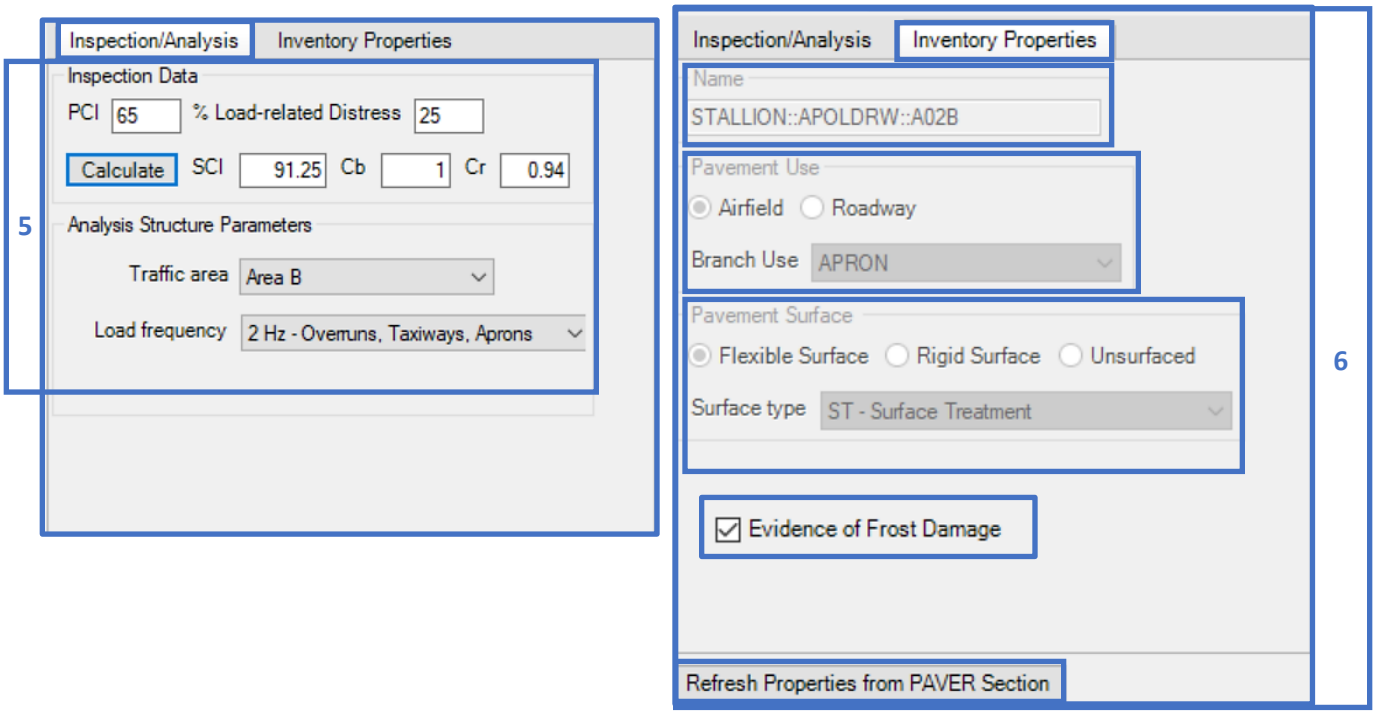


13.2.4 Section tab

5. The Inspection/Analysis tab is comprised of section properties used in an analysis
   - In the Inspection Data section; enter the PCI and % Load-related Distress resulting in the calculated SCI, Cb and Cr. A condition PCI ≤ 40 will activate a load reduction in the Allowable Gross Load (AGL) and an increase in gross weight. The calculated SCI will yield condition factors C_b and C_r that impact the recommended overlay thicknesses for rigid pavements.
   - In the Analysis Structure Parameters tab; the Traffic area and Load Frequency fields can be edited using the drop-lists for flexible structures. For rigid structures, the Traffic area field is available.
     - Use the Traffic area drop-list to select the appropriate Traffic Area (Area A, B, C, or D). If applicable to the analysis (i.e., flexible pavement structure), then select the Load frequency associated with the Analysis-Temp option. Check the box for Evidence of Frost Damage to enable Frost Code, Moisture Content, and Dry Unit Weight columns in the Layers grid. These inputs directly impact the Results by including results for frost conditions

6. The Inventory Properties tab displays characteristics of the section, as defined in the Network inventory. This tab is set to read-only for inventory sections and editable for ad hoc sections
   - The characteristics of the Inventory Properties tab include:
     - Name
     - Pavement Use
       - Airfield or Roadway
       - Branch Use (Runway, Taxiway, Apron, Roadway, Parking area, etc.)
     - Pavement Surface
       - Flexible Surface, Rigid Surface, or Unsurfaced
       - Surface Type
     - Refresh Properties from PAVER Section becomes available once an inventory section's properties have been edited.

- If Consider Frost is checked in Evaluation Manager, the box for Evidence of Frost Damage will be checked by default and enables Frost Code, Moisture Content, and Dry Unit Weight columns in the Layers grid. These inputs directly impact the Results by including results for frost conditions.



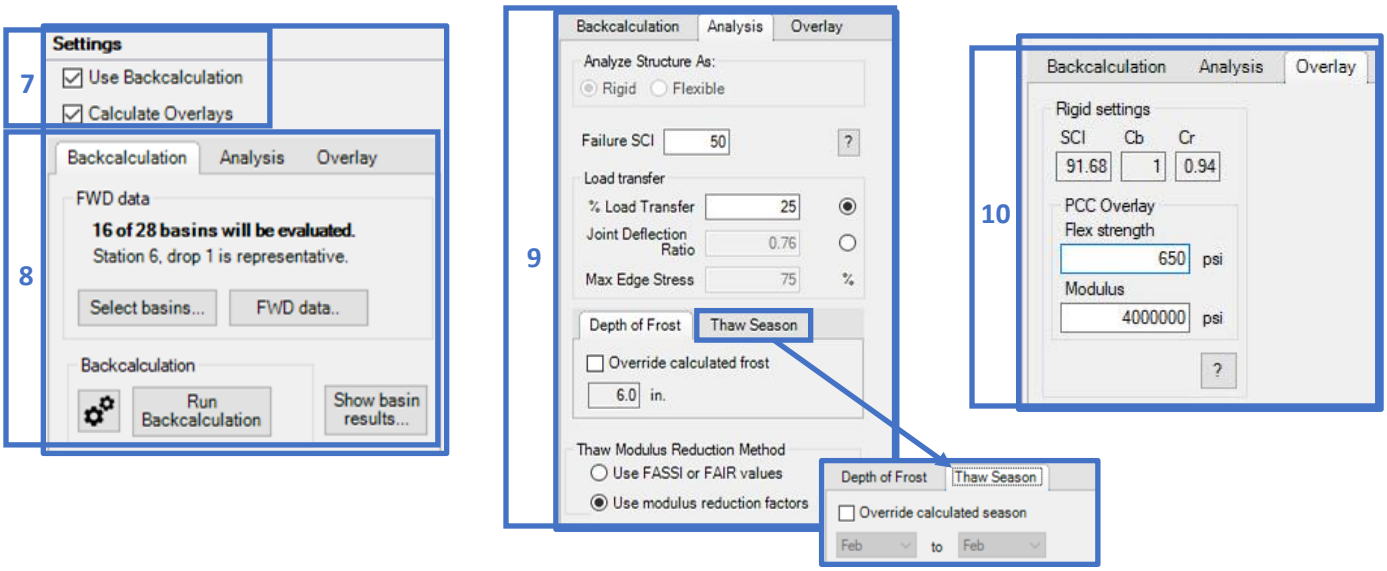
13.2.5 Settings

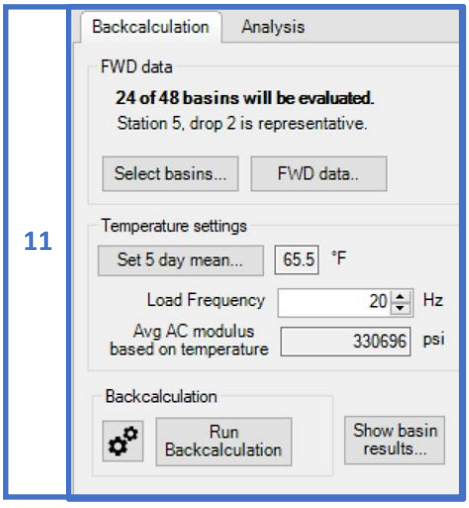
7. Settings comprises of Use Backcalculation, Calculate Overlays and the Backcalculation (displayed when Use Backcalculation is turned on), Analysis, and Overlay (rigid pavements only) tabs.
   - Check the Use Backcalculation box to enable the Backcalculation tab options.
   - Check the Calculate Overlays box to display overlays in Results for pavements that cannot support the assigned traffic.
8. Backcalculation tab for a rigid pavement
   - FWD data
     - Select FWD data to open the FWD Data Manager which allows you to Import new files and Assign FWD files to sections.
     - Once the FWD data is added, choose Select Basins to select the basins to be used for Backcalculation. Specific basins can be selected by clicking on a point, or by selecting a range of points by dragging the cursor across the graph. See Chapter 15 FWD data for more information.

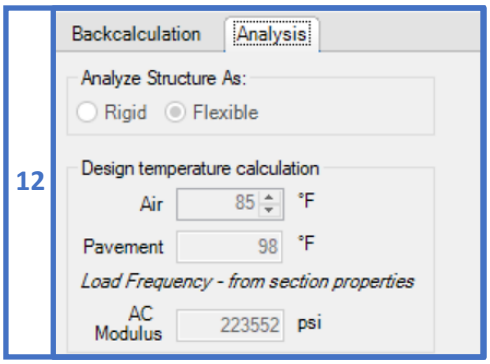
- Backcalculation
  - Select to open the Backcalculation Parameters form where you can:
    - Set Backcalculation to use RMSE or Error
    - Set Backcalculation thresholds
    - Identify when iterations will terminate
      - Select Run Backcalculation to calculate and display the Detailed Basin Results.
      - The Show basin results… button is enabled after Backcalculation is performed.

9. Analysis tab for a rigid pavement
   - Analyze Structure As displays the pavement surface; Rigid or Flexible, extracted from the Section's inventory data.
   - Failure SCI allows you to set the failure criteria. Click on ? icon for definitions of the failure criteria.
   - Use the Load transfer options; % Load Transfer or Joint Deflection Ratio to change the Max Edge Stress. The defaults are set for a rigid pavement with good load transfer. Increasing the Max Edge Stress results in lower Allowable Gross Loads (AGL) and allowable passes.
   - If Evidence of Frost Damage is checked; the Depth of Frost tab, Thaw Season tab and the Thaw Modulus Reduction Method option will populate at the bottom of the Analysis tab. Use these options to override values/settings derived from the selected Weather station and Evaluation Manager.
10. Overlay tab for a rigid pavement
    - Rigid settings displays the SCI, Cb, and Cr values calculated from the Edit Section Properties form.
    - The default PCC Overlay Flex strength and Modulus values are displayed and are editable. Click on ? to view overlay calculation information.
11. Backcalculation tab for a flexible pavement
    - FWD data
      - Select FWD data to open the FWD Data Manager which allows you to Import new files and Assign FWD files to sections.
      - Once the FWD data is added, choose Select Basins to select the basins to be used for Backcalculation. Specific basins can be selected by clicking on a point, or by selecting a range of points by dragging the cursor across the graph. See Chapter 15 FWD data for more information.
    - Temperature settings
      - If Temperature in Backcalculation Options will be used, select Set 5 day mean and enter the daily high and low temperatures; resulting in the 5 day mean.
      - Set the appropriate Load Frequency value.
      - Avg AC modulus based on temperature displays based on the 5 day mean, Load Frequency, and Asphalt Concrete pavement thickness.

12. Analysis tab for a flexible pavement
    - Analyze Structure As displays the pavement surface; Rigid or Flexible, which is derived from the Section's inventory data.
    - Design temperature calculation (flexible pavement only) displays the Air, Pavement, and AC Modulus values (based on the Load frequency set in Edit section properties).
    - If Evidence of Frost Damage is checked; the Depth of Frost tab, Thaw Season tab and the Thaw Modulus Reduction Method option will populate at the bottom of the Analysis tab. Use these options to override values/settings derived from the selected Weather station and Evaluation Manager.

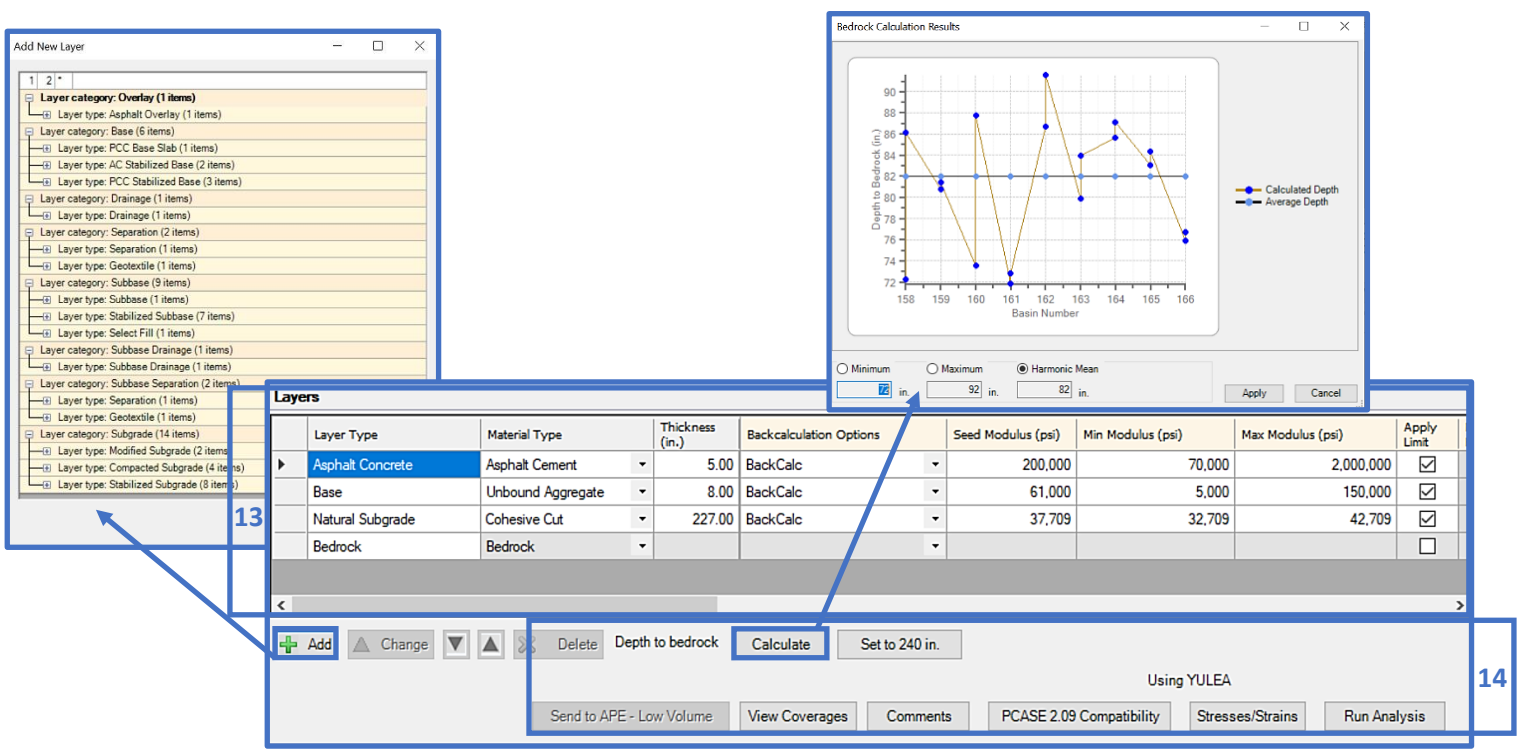


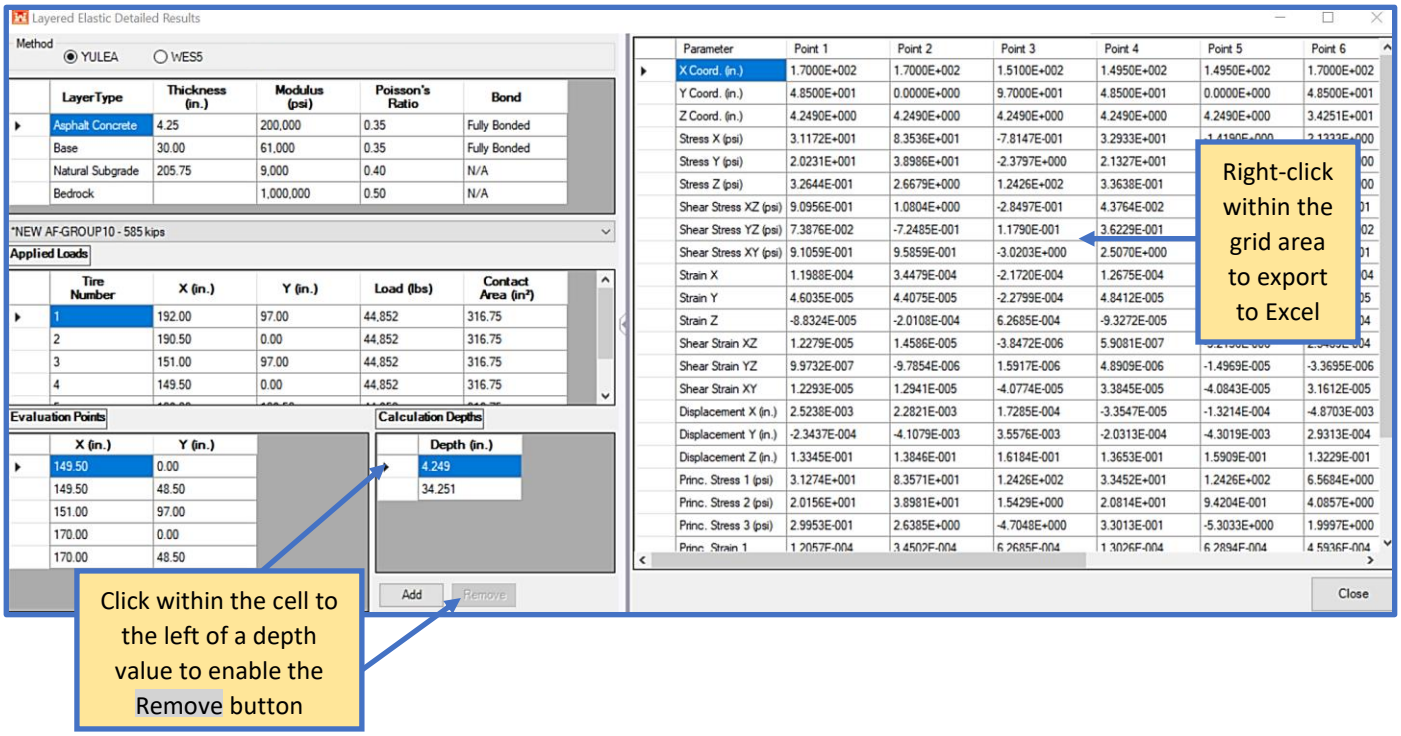




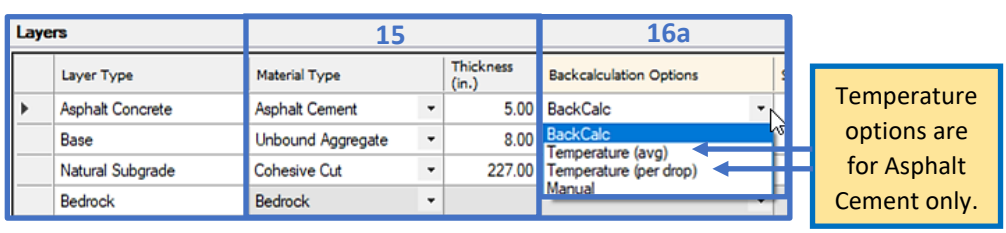
13.2.6 Layers

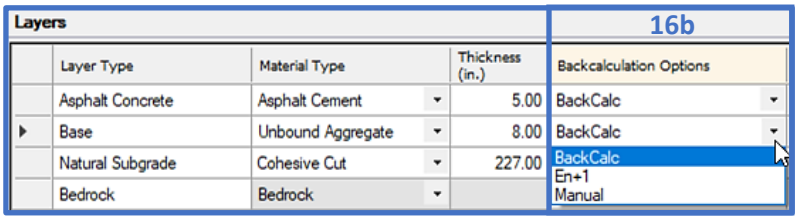
13. The Layers grid populates a default structure for the specified pavement type. The layer model columns include: Layer Type, Material Type, Thickness, Backcalculation Options, Seed Modulus, Min Modulus, Max Modulus, Apply Limit, Modulus Hit Limit?, Backcalculated Modulus, Analysis Options, Modulus (used for analysis), Poisson's Ratio, Bond, failure criteria flags, and Effective k (rigid only).
14. Layer types and their coinciding material types can be added or edited using the Add or Change buttons beneath the Layers grid. To Add a layer, select the Layer category and the respective material type. The Change layer button becomes enabled when the selected layer can be modified. The up and down arrows enable when the selected layer can be moved. Select Calculate to determine the Depth to bedrock after running backcalculation. *Note: The Calculate Depth to Bedrock option is only enabled when FWD data is assigned to the selected section and at least one basin is selected.* Select Set to 240 in. to reestablish the subgrade depth based on the layer thicknesses above. Select Send to APE – Low Volume (option is displayed for flexible structures when FWD data is associated with the layer model) to send the current model to APE and use the Low Volume method to calculate CBRs. View Coverages opens a form that displays vehicle pass-to-coverage ratios. Select the Comments button to add notes on the analysis. Select PCASE 2.09 Compatibility to change the LEEP Criteria to WESDEF/WESPAVE and /or the Tire Contact Option to Assume Constant Tire Contact Area (click the ? button for details of the options). The Stresses/Strains button launches a window (shown on next page) that displays a table of the layer structure's stresses and strains data and allows editing of depths in which to perform analyses. Select Run Analysis to initialize the calculation process once all evaluation parameters are established.





15. Select the appropriate Material Type and input the Thickness for each layer.
16. Select an option from Backcalculation Options for each layer (for instructions on running backcalculation see Chapter 15 FWD Data):
    a. Asphalt Cement surface layer: BackCalc, Temperature (avg), Temperature (per drop), or Manual.
    b. Portland Cement Concrete surface layer and all sublayers (except subgrade): BackCalc, En+1, or Manual.
    c. Subgrade layer: BackCalc or Manual.





Layers — 16c

Layer Type	Material Type	Thickness (in.)	Backcalculation Options
Asphalt Concrete	Asphalt Cement	5.00	BackCalc
Base	Unbound Aggregate	8.00	BackCalc
Natural Subgrade	Cohesive Cut	227.00	BackCalc
Bedrock	Bedrock		BackCalc / Manual

17. Default Seed Modulus, Min Modulus, Max Modulus and Apply Limit settings are provided. To change a value, click on a cell to input a new value.

Layers — 17

Layer Type	Material Type	Thickness (in.)	Backcalculation Options	Seed Modulus (psi)	Min Modulus (psi)	Max Modulus (psi)	Apply Limit
Asphalt Concrete	Asphalt Cement	5.00	BackCalc	200,000	70,000	2,000,000	☑
Base	Unbound Aggregate	8.00	BackCalc	61,000	5,000	150,000	☑
Natural Subgrade	Cohesive Cut	227.00	BackCalc	9,000	1,500	50,000	☑
Bedrock	Bedrock						☐

18. Once the Backcalculation operation is complete, the backcalculated moduli values for each layer will transpose to the Backcalculated Modulus column cells.
19. Select the appropriate options from Analysis Options for each layer:
    a. Asphalt Cement surface layer: BackCalc, Temperature, or Manual.
    b. Portland Cement Concrete surface layer and all sublayers (except subgrade): BackCalc, En+1 or Manual.
    c. Subgrade layer: BackCalc or Manual.
20. The established moduli that will be used for analysis are displayed in the Modulus column.
21. Default values for Poisson's Ratio and Bond are provided. These fields are editable.
22. Surface and Subgrade failure criteria-flags employed by the LEEP analysis procedure are provided, as well as a Controlling Criteria flag.

Layers — 18, 19, 20, 21, 22

Layer Type	Material Type	Thickness (in.)		Apply Limit	Modulus Hit Limit?	Backcalculated Modulus (psi)	Analysis Options	Modulus (psi)	Poisson's Ratio	Bond	Surface ?	Subgrade ?	Controlling Criteria
Asphalt Concrete	Asphalt Cement	5.00	0	☑	No	259,702	BackCalc	259,702	0.35	Fully Bond...	☑	☐	☐
Base	Unbound Aggregate	8.00	0	☑	No	91,923	BackCalc	91,923	0.35	Fully Bond...	☐	☐	☐
Natural Subgrade	Cohesionless Cut	227.00	1	☑	No	21,622	BackCalc	21,622	0.40	Fully Bond...	☐	☑	☑
Bedrock	Bedrock			☐				1,000,000	0.50		☐	☐	☐

13.2.7 Results

23. Results from the pavement analysis are displayed in the Results section. Results provided are pavement allowable gross load (AGL), allowable passes, ACN, PCN calculations and designations. Overlay requirements and associated Mission and freeze/thaw ACNs and PCNs are also provided (if applicable).

Results — 23

C-130H

Evaluation Load (lb)	Evaluation Passes	AGL (lb)	Allowable Passes	ACN	PCN	PCN String	ACN/PCN	ACN/PCN Rating	AC Overlay (in.)
130,000	14,401	163,391	180,229	20	26	26/F/A/W/T	0.8	Green	0.0

13.3 LEEP Examples

13.3.1 Evaluate pavements by manually inputting modulus values

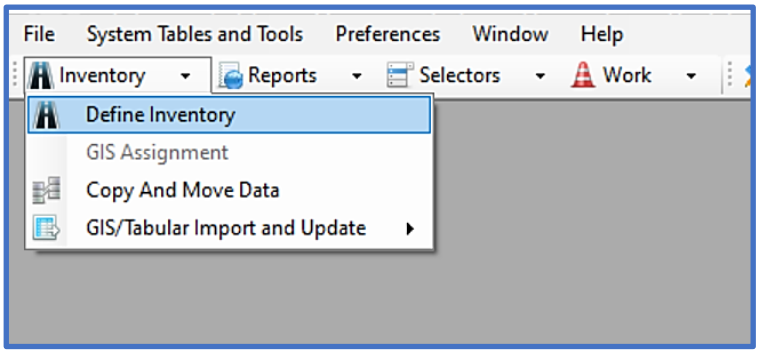
Evaluate the pavements described in Tables 1 and 2.

Table 1.					
Allen Army Airfield, Fort Greely, AK (Service – Army)					
Runway 01-19, Section R03C Surface – fair condition (PCI=60; load distress=20%) Evaluate for Army Class IV > 5,000 ft and < 9,000 ft Use the default values for Poisson's Ratio and Bond					
Material Properties					
Layer Type / Classification	**Thickness in. (mm)**	**Modulus psi (MPa)***	**Frost Code**	**% Moisture**	**Dry Unit Weight pcf (kg/m³)**
Asphalt Concrete	4.5 (114)	493,194 (3,400)	NFS	0	145 (2,323)
Unbound Aggregate Base	8.0 (203)	83,966 (579)	NFS	5	135 (3,429)
Gravely Sand & Silt (cohesionless cut)	--	14,179 (98)	F3	10	110 (2,794)
*Backcalculated values from FWD results performed the previous summer					

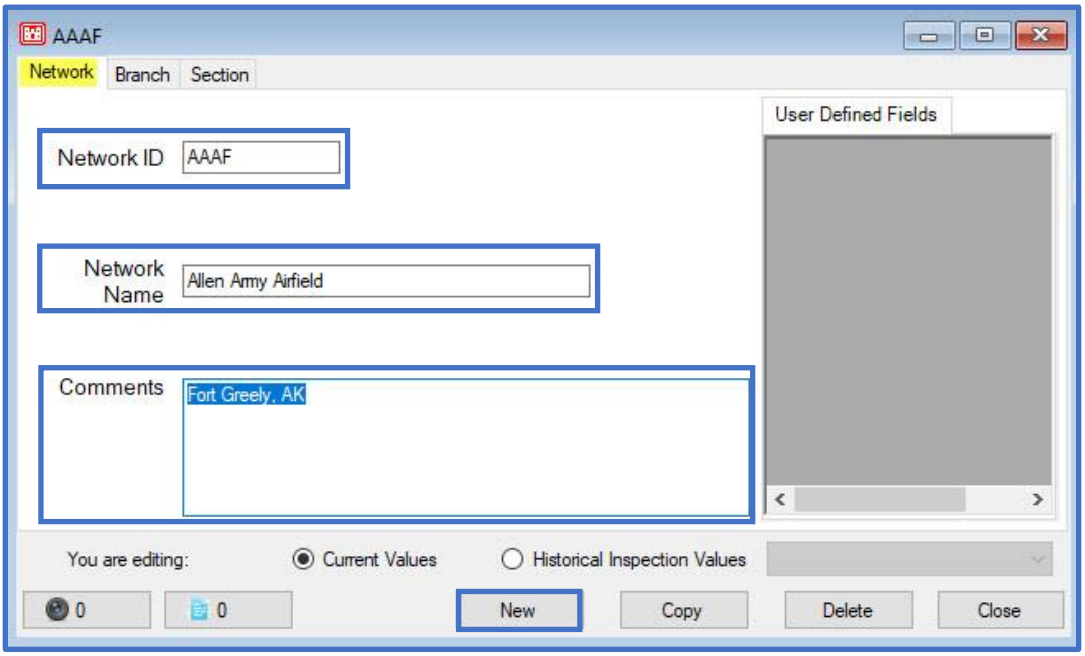
Allen Army Airfield, Fort Greely, AK; Runway 01-19, Section R03C

Step 1. Define the Inventory

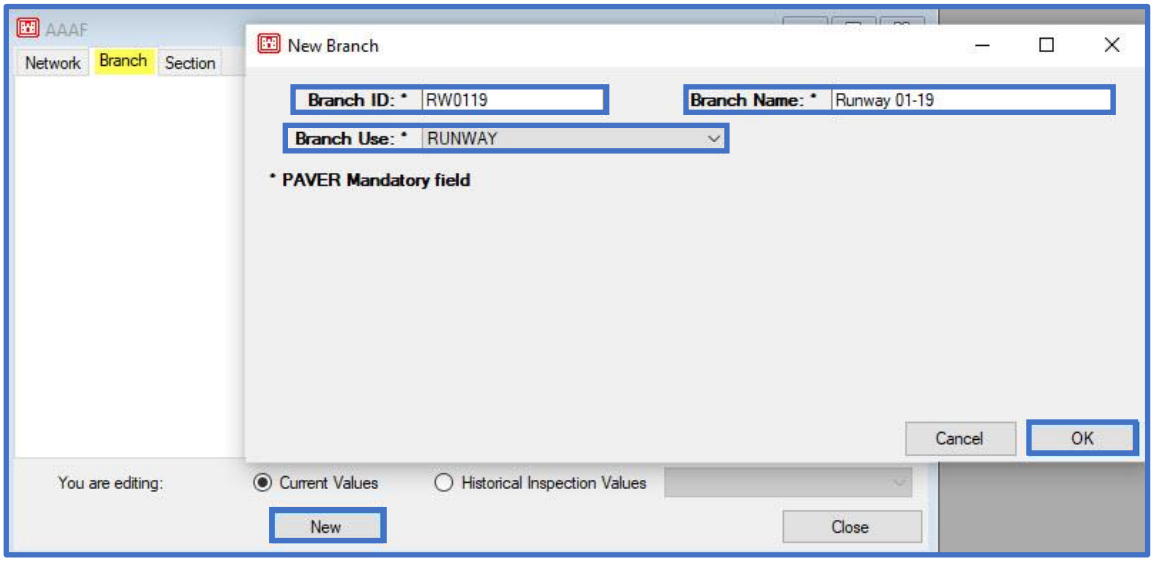
- Use the Inventory pulldown and select Define Inventory



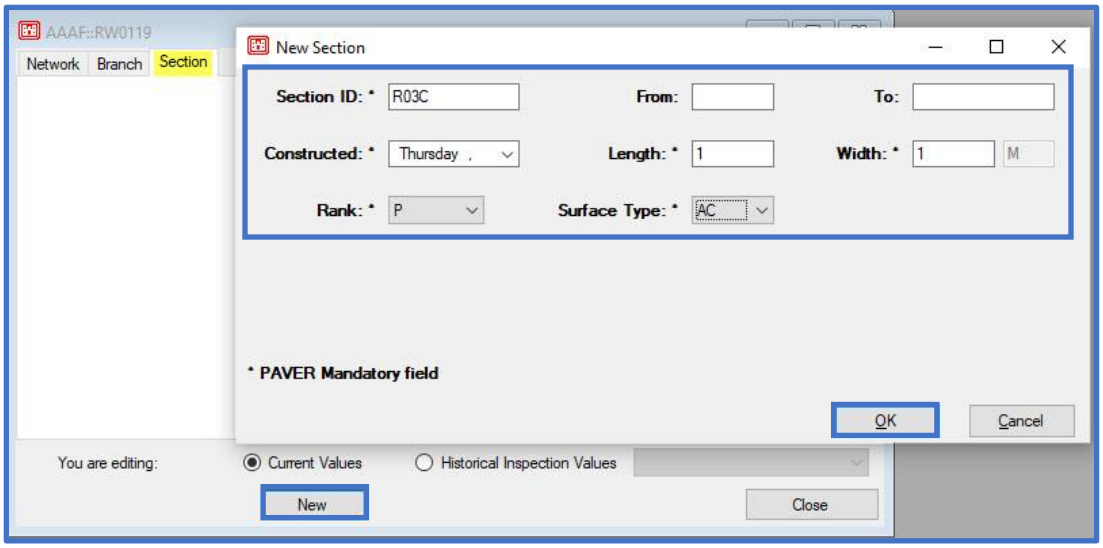
- On the Inventory form, select the Network tab
- Select New
- Type in the Network ID, Network Name, and Comments (optional)



- On the Inventory form, select the Branch tab
- Select New
- Type in the Branch ID, Branch Name, and use the pulldown to select the Branch Use
- Select OK

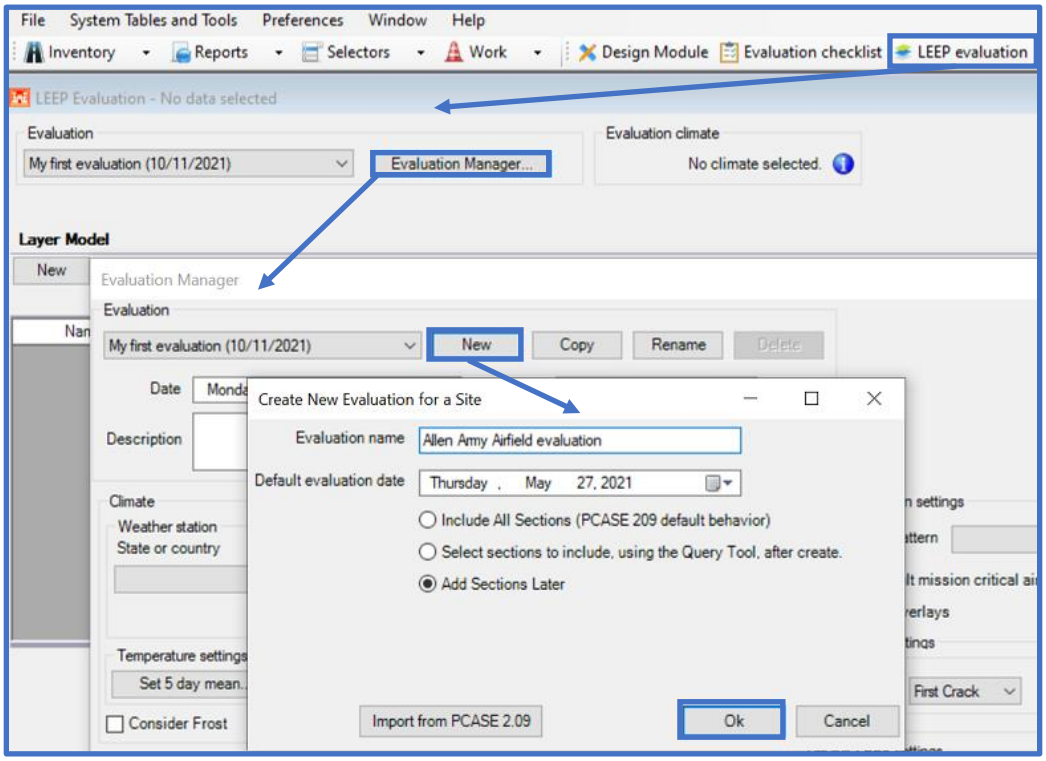


- On the Inventory form, select the Section tab
- Select New
- Type in the Section ID, Length, and Width (required)
- Type in From and To (optional)
- Use the pulldown to select the Constructed date, Rank, and Surface Type (required)
- Select OK

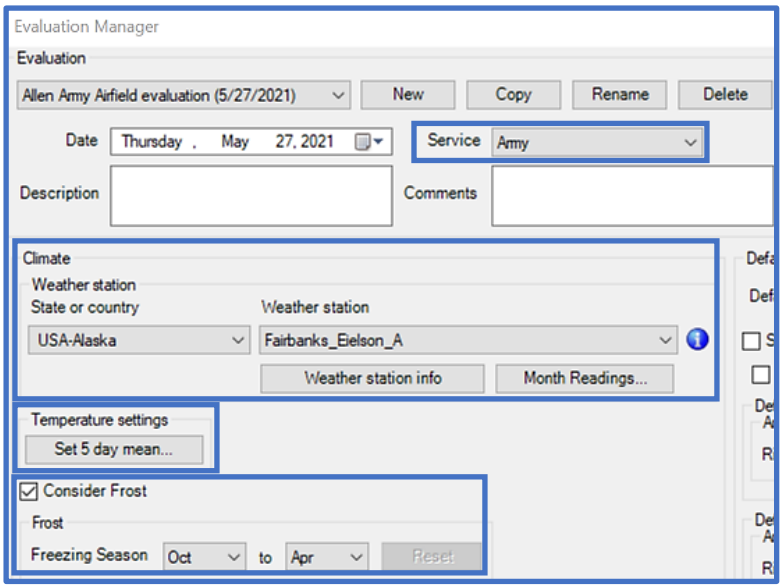


Step 2. Set up the Evaluation

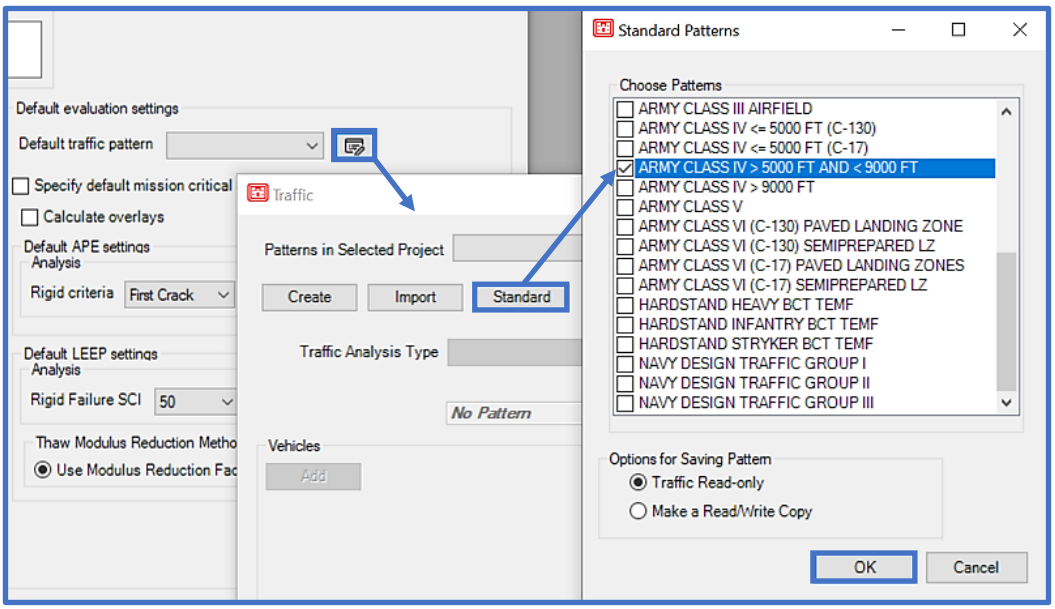
- Select LEEP evaluation
- On the LEEP evaluation form; select Evaluation Manager
- On the Evaluation Manager form; select New
- On the Create New Evaluation for the Site form:
    - Type in the Evaluation name
    - Use the pulldown to select the Default evaluation date
    - Select the Add Sections Later radio button
    - Select Ok



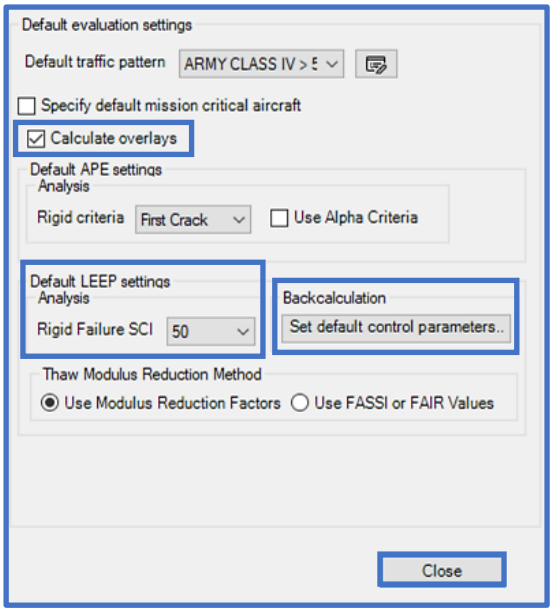
- On the Evaluation Manager form:
  - Select Army from the Service drop-list field
  - Select the appropriate Weather station from the Climate section
  - Check the box for Consider Frost; the Freezing season will populate based on the selected Weather station information
  - Input temperatures to set the 5 Day Mean (if applicable) in the Temperature settings section



- In the Default evaluation settings section; click on the Default traffic pattern icon
- On the Traffic form; select Standard
- On the Standard Patterns form; select Army Class IV > 5,000 ft and < 9,000 ft
- Select OK

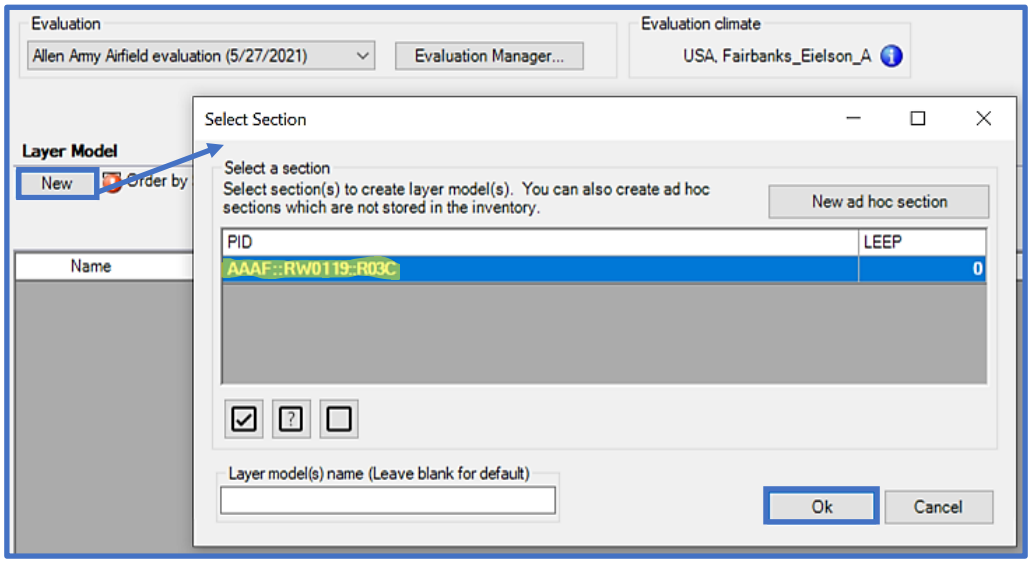


- In the Evaluation Manager form:
  - In Default evaluation settings; check the box for Calculate Overlays
  - Under Default LEEP settings; ensure the Rigid failure SCI is set to 50
  - Backcalculation parameters can be set now, or applied at the section-level from within the LEEP evaluation form
  - Select Close to exit the Evaluation Manager and return to LEEP evaluation

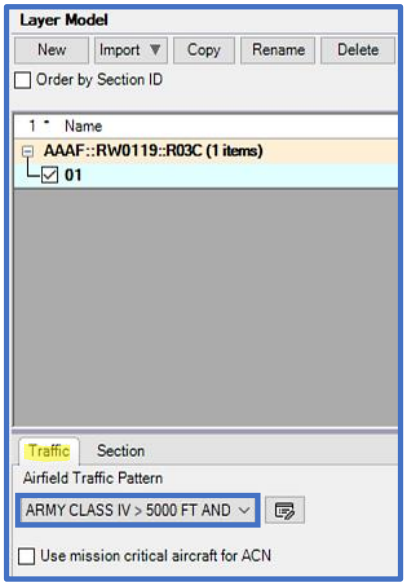


Step 3. Analyze the pavement using LEEP evaluation

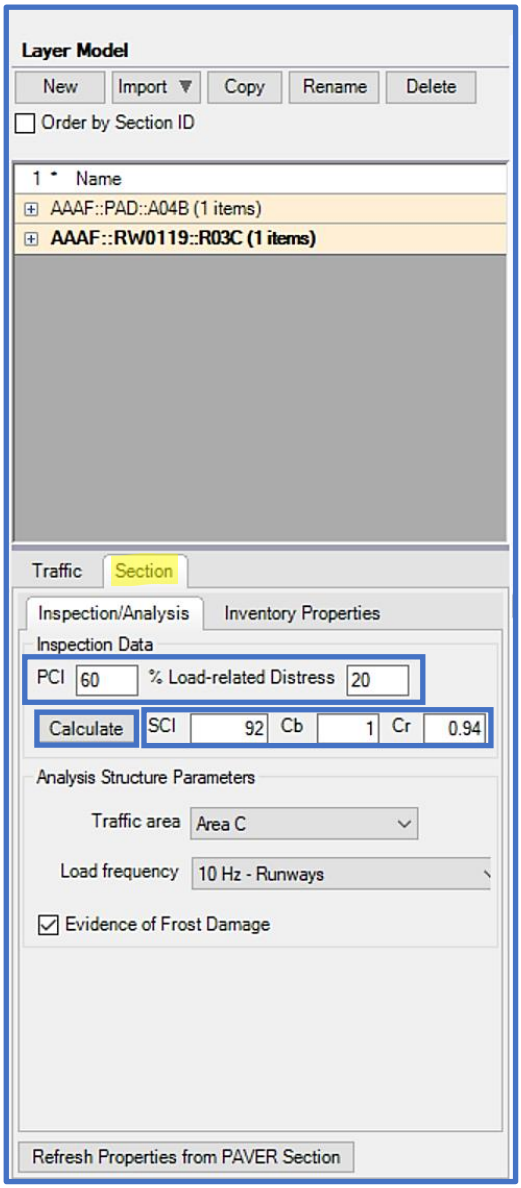
- On the LEEP evaluation form; select New
- On the Select Section form; select the appropriate section PID
- Select Ok



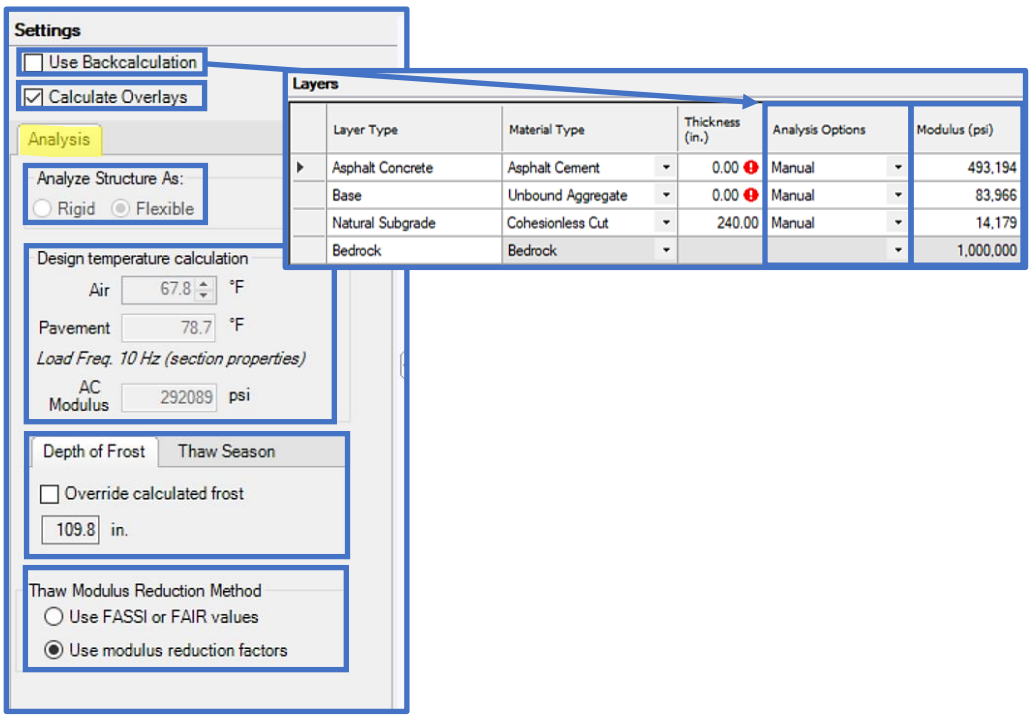
- On the LEEP evaluation form, under Layer Model, the selected section PID populates
- Select the Traffic tab
- Use the Airfield Traffic Pattern drop-list to select the appropriate traffic pattern or click on the icon to select a standard pattern



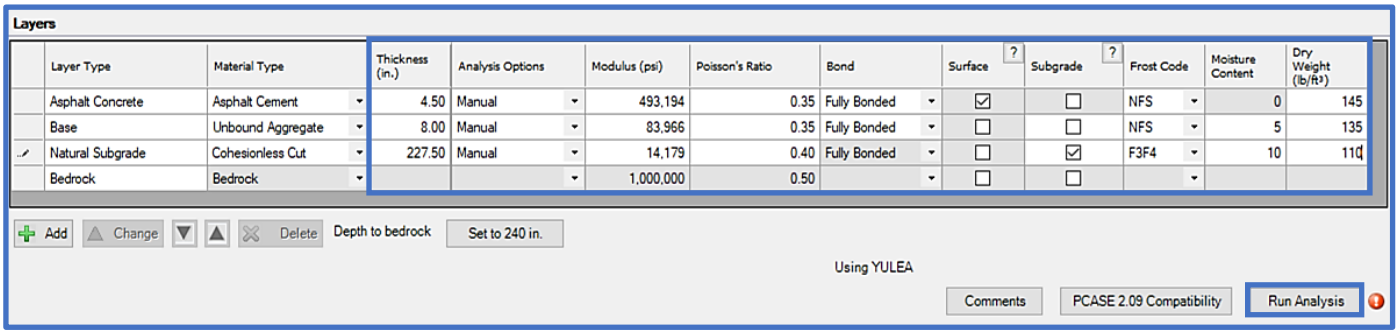
- Select the Section tab:
  - Input the appropriate PCI and % Load distress values
  - Select Calculate to display the resultant SCI, Cb, and Cr
  - All other default properties shown are correct, no need for further edits



- Under Settings
    - Uncheck Use Backcalculation, since modulus values will be entered manually. The Analysis Options in the layer model grid should be set to Manual. Input Modulus values for each layer (see below or Table 1).
    - Calculate overlays is checked as indicated in Evaluation Manager
    - Under the Analysis tab
        - Flexible is selected, as indicated in Define Inventory
        - The Design temperature calculation results display, but will not be used for manual entry of moduli.
        - The Depth of frost displays
        - Select Use modulus reduction factors for the Thaw Modulus Reduction Method



- On the LEEP evaluation form, in the Layers grid, a default pavement section displays
- Input the Thickness, Frost Code, Moisture Content, and Dry Unit Weight values for each layer (see below or Table 1).
- Keep the defaults for Poisson's Ratio and Bond
- Select Run Analysis



Layers

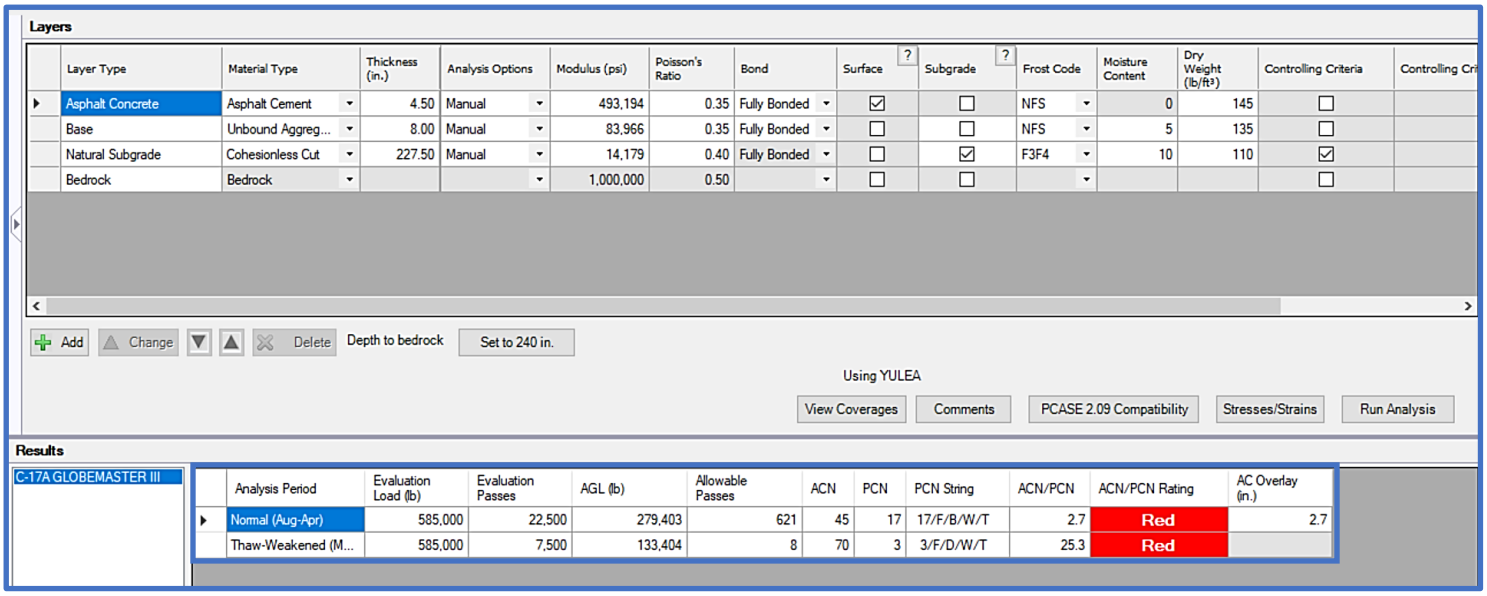
Layer Type	Material Type	Thickness (in.)	Analysis Options	Modulus (psi)	Poisson's Ratio	Bond	Surface	Subgrade	Frost Code	Moisture Content	Dry Weight (lb/ft³)
Asphalt Concrete	Asphalt Cement	4.50	Manual	493,194	0.35	Fully Bonded	☑	☐	NFS	0	145
Base	Unbound Aggregate	8.00	Manual	83,966	0.35	Fully Bonded	☐	☐	NFS	5	135
Natural Subgrade	Cohesionless Cut	227.50	Manual	14,179	0.40	Fully Bonded	☐	☑	F3F4	10	110
Bedrock	Bedrock			1,000,000	0.50		☐	☐			

Add | Change | Delete | Depth to bedrock | Set to 240 in.

Using YULEA

Comments | PCASE 2.09 Compatibility | Run Analysis

- Results display



Layers

Layer Type	Material Type	Thickness (in.)	Analysis Options	Modulus (psi)	Poisson's Ratio	Bond	Surface	Subgrade	Frost Code	Moisture Content	Dry Weight (lb/ft³)	Controlling Criteria	Controlling Cri
Asphalt Concrete	Asphalt Cement	4.50	Manual	493,194	0.35	Fully Bonded	☑	☐	NFS	0	145	☐	
Base	Unbound Aggreg...	8.00	Manual	83,966	0.35	Fully Bonded	☐	☐	NFS	5	135	☐	
Natural Subgrade	Cohesionless Cut	227.50	Manual	14,179	0.40	Fully Bonded	☐	☑	F3F4	10	110	☑	
Bedrock	Bedrock			1,000,000	0.50		☐	☐				☐	

Add | Change | Delete | Depth to bedrock | Set to 240 in.

Using YULEA

View Coverages | Comments | PCASE 2.09 Compatibility | Stresses/Strains | Run Analysis

Results

C-17A GLOBEMASTER III

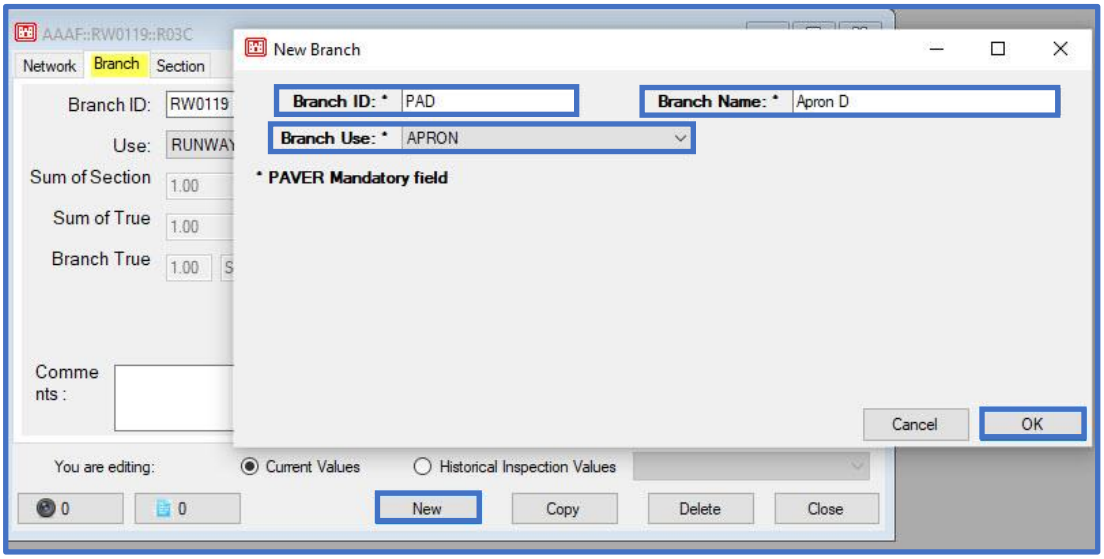
Analysis Period	Evaluation Load (lb)	Evaluation Passes	AGL (lb)	Allowable Passes	ACN	PCN	PCN String	ACN/PCN	ACN/PCN Rating	AC Overlay (in.)
Normal (Aug-Apr)	585,000	22,500	279,403	621	45	17	17/F/B/W/T	2.7	Red	2.7
Thaw-Weakened (M...	585,000	7,500	133,404	8	70	3	3/F/D/W/T	25.3	Red	

Table 2.					
Allen Army Airfield, Fort Greely, AK (Service – Army)					
Apron D, Section A04B Surface – good condition (PCI=80; load distress=10%) Evaluate for Army Class IV > 5,000 ft and < 9,000 ft Use the default values for Poisson's Ratio and Bond					
Layer Type / Classification	**Thickness in. (mm)**	**Modulus psi (MPa)***	**Frost Code**	**% Moisture**	**Dry Unit Weight pcf (kg/m³)**
Portland Cement Concrete Flex strength = 650 psi (4.48 MPa)	12 (305)	7,530,519 (51,921)	NFS	0	145 (2,323)
Base Sandy Gravel (GW)	8 (203)	286,487 (1,975)	NFS	5	135 (3,429)
Gravely Sand & Silt (cohesionless cut)	--	26,658 (184)	F3	10	110 (2,794)
*Backcalculated values from FWD results performed the previous summer					

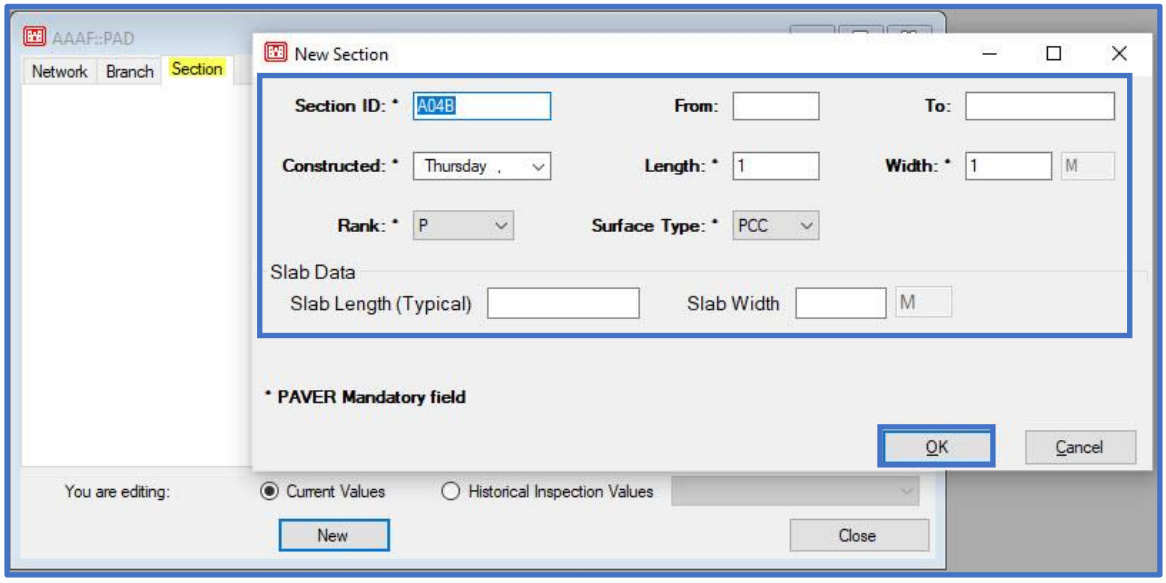
Allen Army Airfield, Fort Greely, AK; Apron D, Section A04B

Step 1. Define the Inventory

- Select Define Inventory from the Inventory toolbar drop-list
  - Once the inventory form opens select the Network tab
  - If the Network ID displayed in the List Selector is not AAAF, select the appropriate Network ID.
- On the Inventory form, in the same Network, select the Branch tab again
  - Select New
  - Type in the Branch ID, Branch Name, then select the Branch Use from the drop-list
  - Select OK



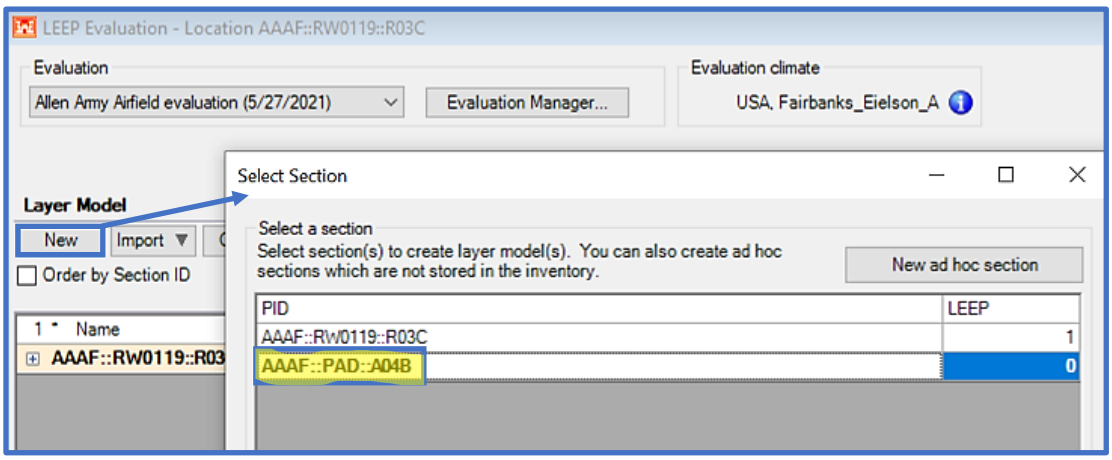
- On the inventory form, select the Section tab
  - Select New
  - Type in the Section ID, Length, and Width (required)
  - Type in From, To and Slab Data (optional)
  - Use the drop-lists to select the Constructed date, Rank, and Surface Type (required)
  - Select OK

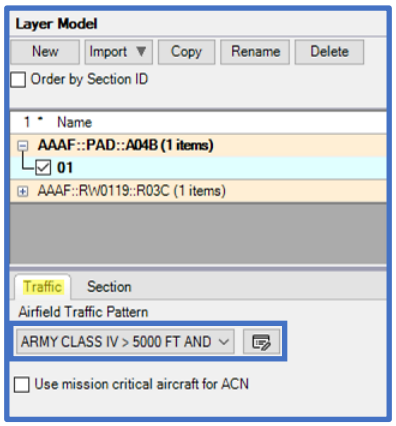


Evaluation Manager (Step 2) was accomplished in the previous example (Runway 01-19, Section R03C); proceed to Step 3.

Step 3. Analyze the pavement using LEEP evaluation

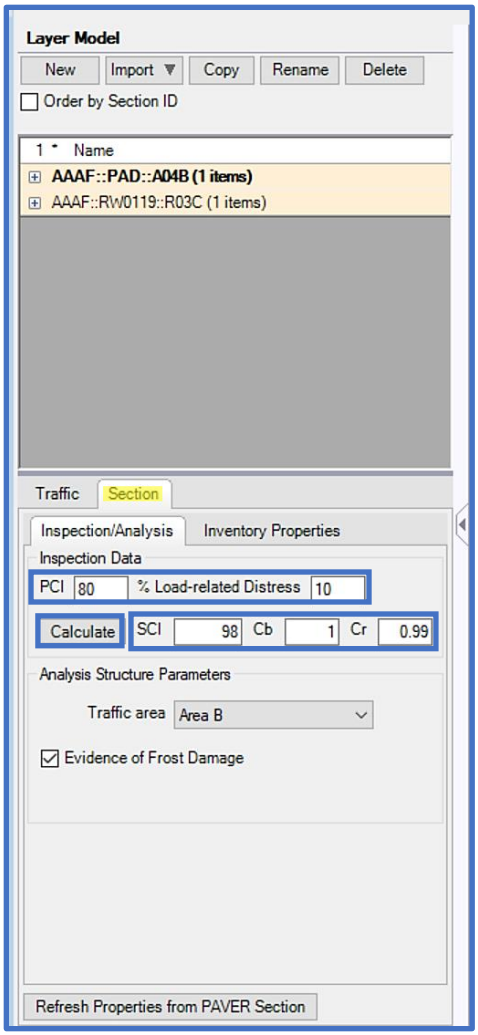
- On the LEEP evaluation form; select New
- On the Select Section form; select the appropriate section PID
- Select Ok



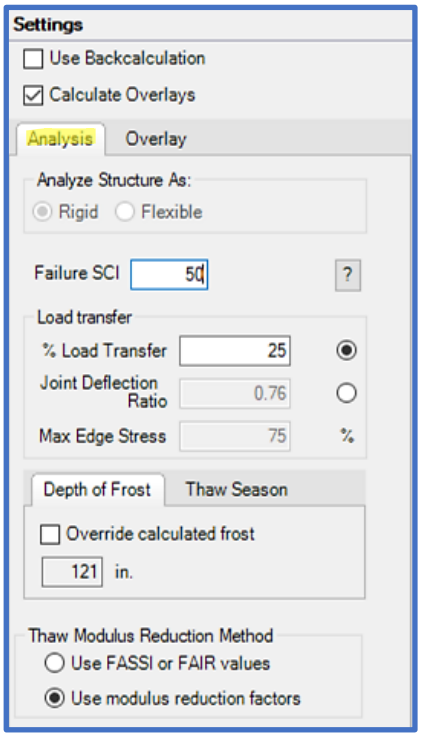


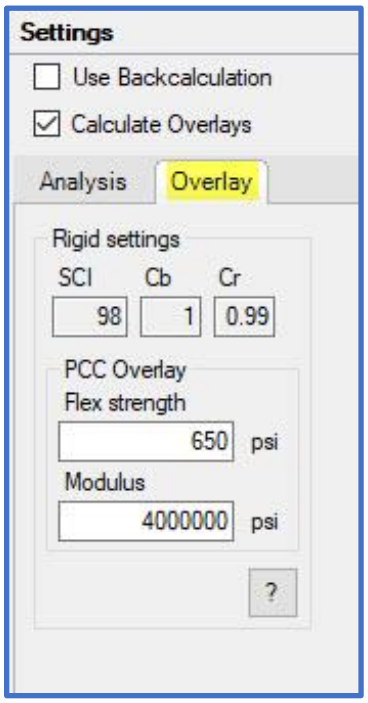
- On the LEEP evaluation form, under Layer Model, the selected section PID populates
- Select the Traffic tab
- Use the Airfield Traffic Pattern drop-list to select the appropriate Traffic Pattern or click on the icon to select a standard pattern

- Select the Section tab:
  - Input the appropriate PCI and % Load-related Distress values
  - Select Calculate to display the resultant SCI, C_b, and C_r
  - All other properties shown are correct, no need for further edits

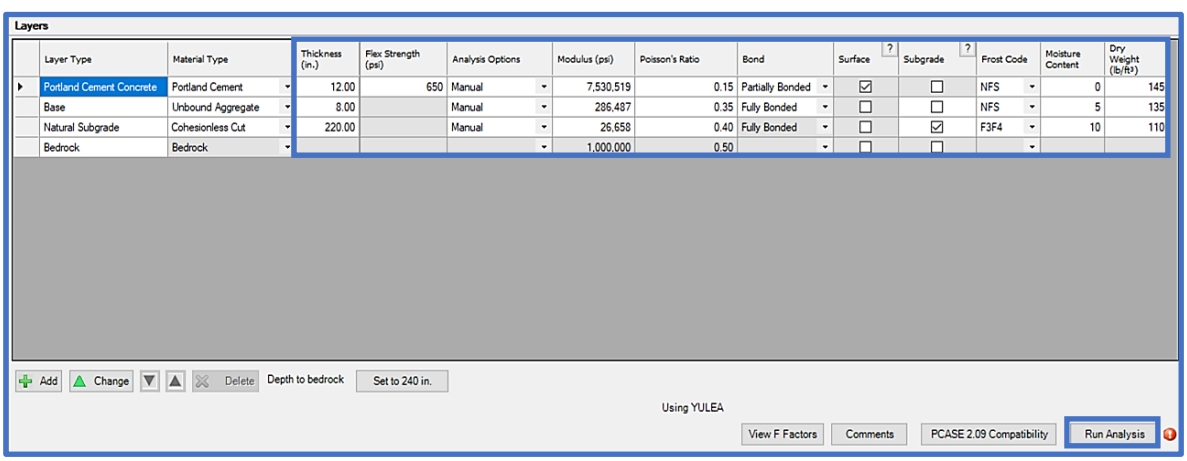


- Under Settings
  - Use Backcalculation is unchecked since modulus values will be entered manually
  - Calculate overlays is checked as indicated in Evaluation Manager
  - Under the Analysis tab
    - Rigid is selected, as indicated in Define Inventory
    - Use the defaults for Load transfer
    - Set the Failure SCI to 50 (for Army analysis)
    - The Depth of Frost displays
    - Select Use modulus reduction factors for the Thaw Modulus Reduction Method
  - Under the Overlay tab
    - The Rigid settings section displays the SCI, Cb, and Cr calculated in the Edit Section form
    - Use the default PCC Overlay Flex strength and Modulus values

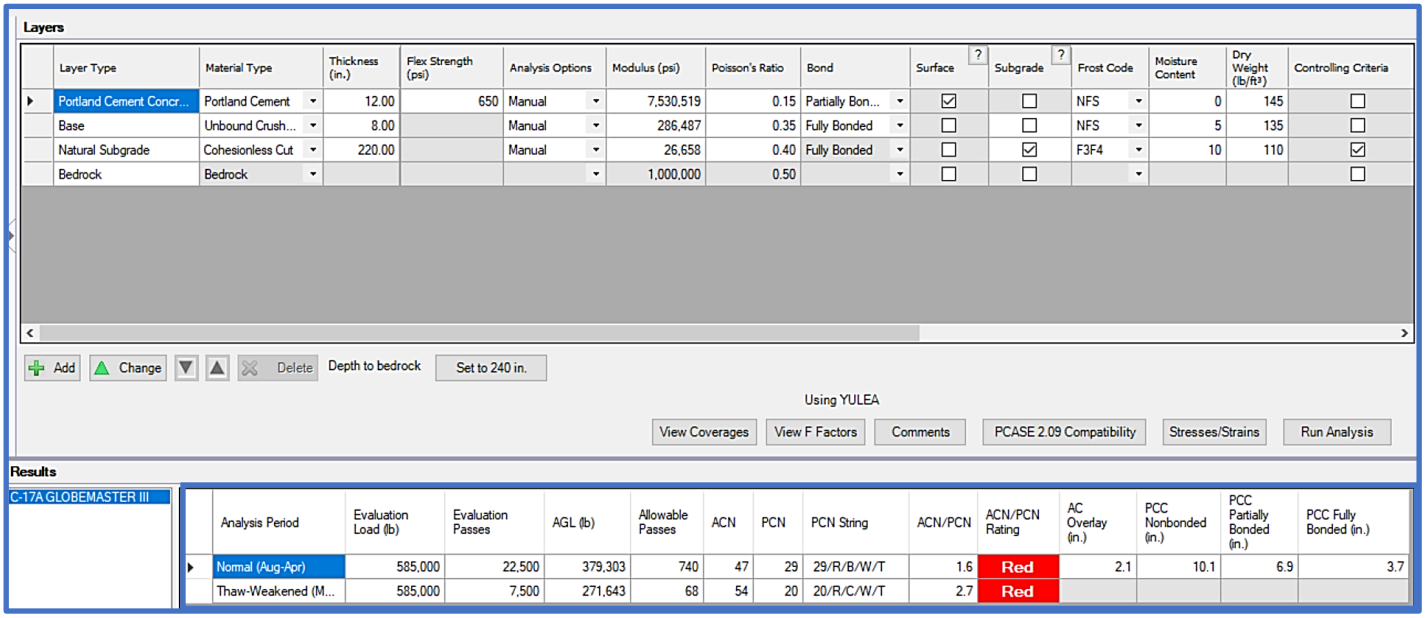




- On the LEEP evaluation form, in the Layers grid, a default pavement section displays
- Input values for Thickness, Modulus, Frost Code, Moisture Content, and Dry Unit Weight for each layer (see below or reference Table 2)
- Use the defaults for Poisson's Ratio and Bond
- Select Run Analysis



- Results display
- Select Close to exit LEEP



Layer Type	Material Type	Thickness (in.)	Flex Strength (psi)	Analysis Options	Modulus (psi)	Poisson's Ratio	Bond	Surface	Subgrade	Frost Code	Moisture Content	Dry Weight (lb/ft³)	Controlling Criteria
Portland Cement Concr...	Portland Cement	12.00	650	Manual	7,530,519	0.15	Partially Bon...	☑	☐	NFS	0	145	☐
Base	Unbound Crush...	8.00		Manual	286,487	0.35	Fully Bonded	☐	☐	NFS	5	135	☐
Natural Subgrade	Cohesionless Cut	220.00		Manual	26,658	0.40	Fully Bonded	☐	☑	F3F4	10	110	☑
Bedrock	Bedrock				1,000,000	0.50		☐	☐				☐

Analysis Period	Evaluation Load (lb)	Evaluation Passes	AGL (lb)	Allowable Passes	ACN	PCN	PCN String	ACN/PCN	ACN/PCN Rating	AC Overlay (in.)	PCC Nonbonded (in.)	PCC Partially Bonded (in.)	PCC Fully Bonded (in.)
Normal (Aug-Apr)	585,000	22,500	379,303	740	47	29	29/R/B/W/T	1.6	Red	2.1	10.1	6.9	3.7
Thaw-Weakened (M...	585,000	7,500	271,643	68	54	20	20/R/C/W/T	2.7	Red				

13.3.2 Evaluate pavements using DCP results

Evaluate the pavement Section A01B, Branch PAMAIN, at Stallion AAF, using the DCP results from example 16.3.2 Manual Data Entry of DCP Data and Performing Analysis and parameters provided in Table 3.

Table 3.		
Stallion AAF, White Sands, NM (Service – Army)		
PAMAIN, Section A01B Surface pavement – Flexible Pavement structure from DCP results; reference Example 16.3.2 Frost is not a consideration Calculate overlays		
Traffic		
Aircraft	**Weight – A, B [lb (kg)]**	**Passes – A, B, C**
C-130H	130,000 (58,967)	14,400
UH-60	16,600 (7,530)	4,800

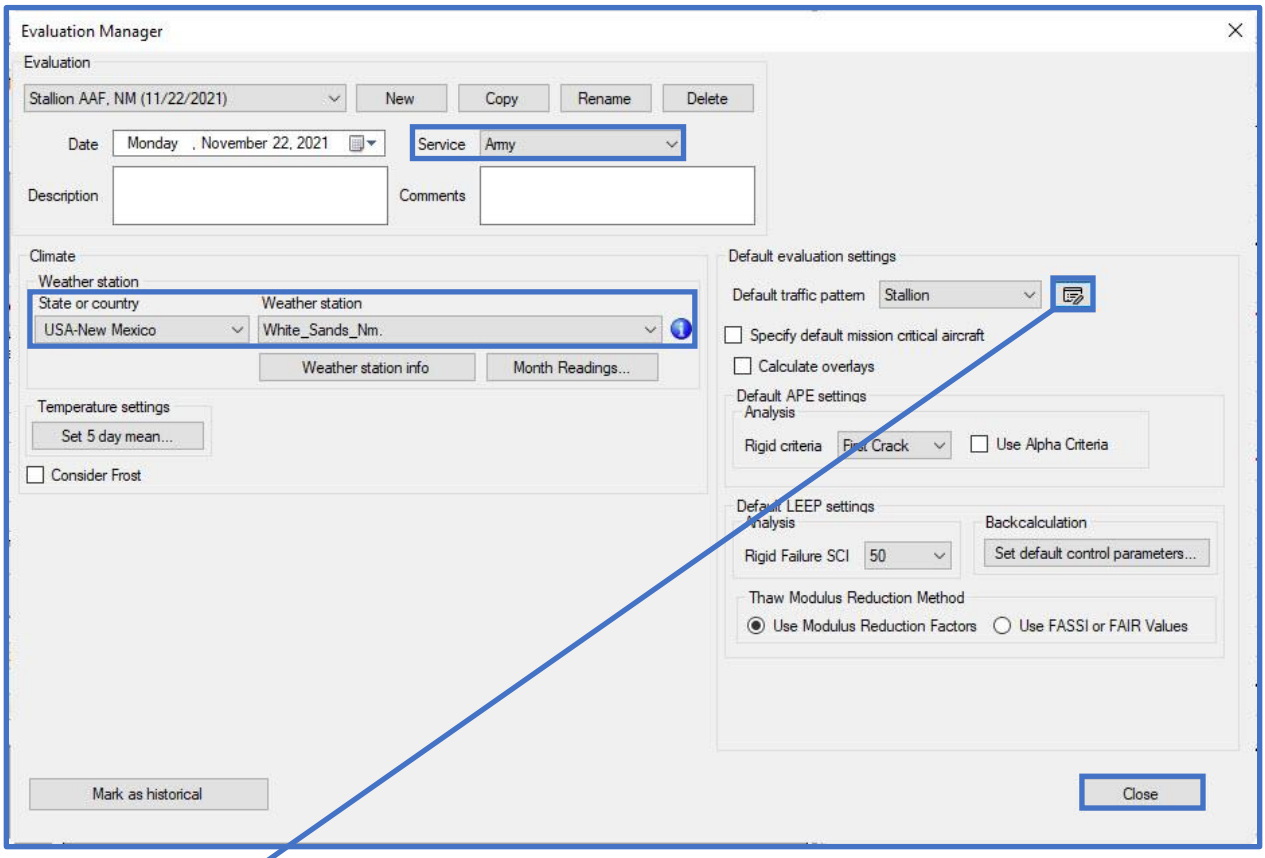
Step 1. Open the database containing the DCP data and analysis

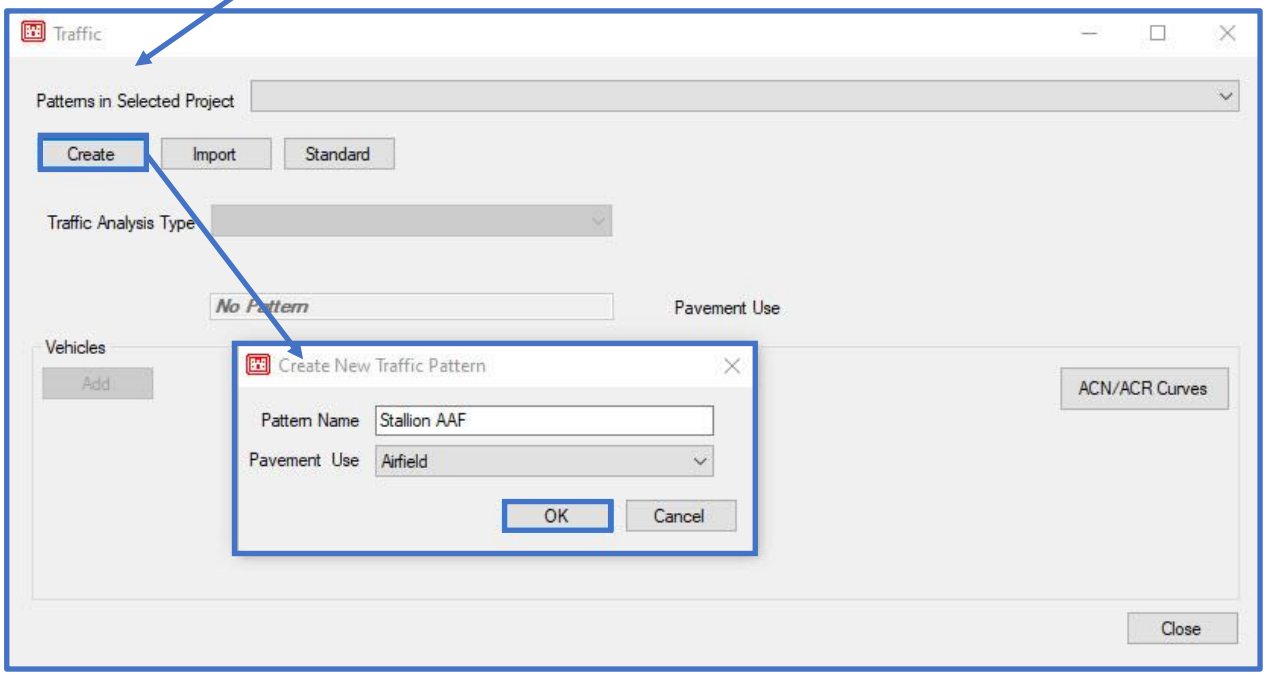
Step 2. Open LEEP evaluation

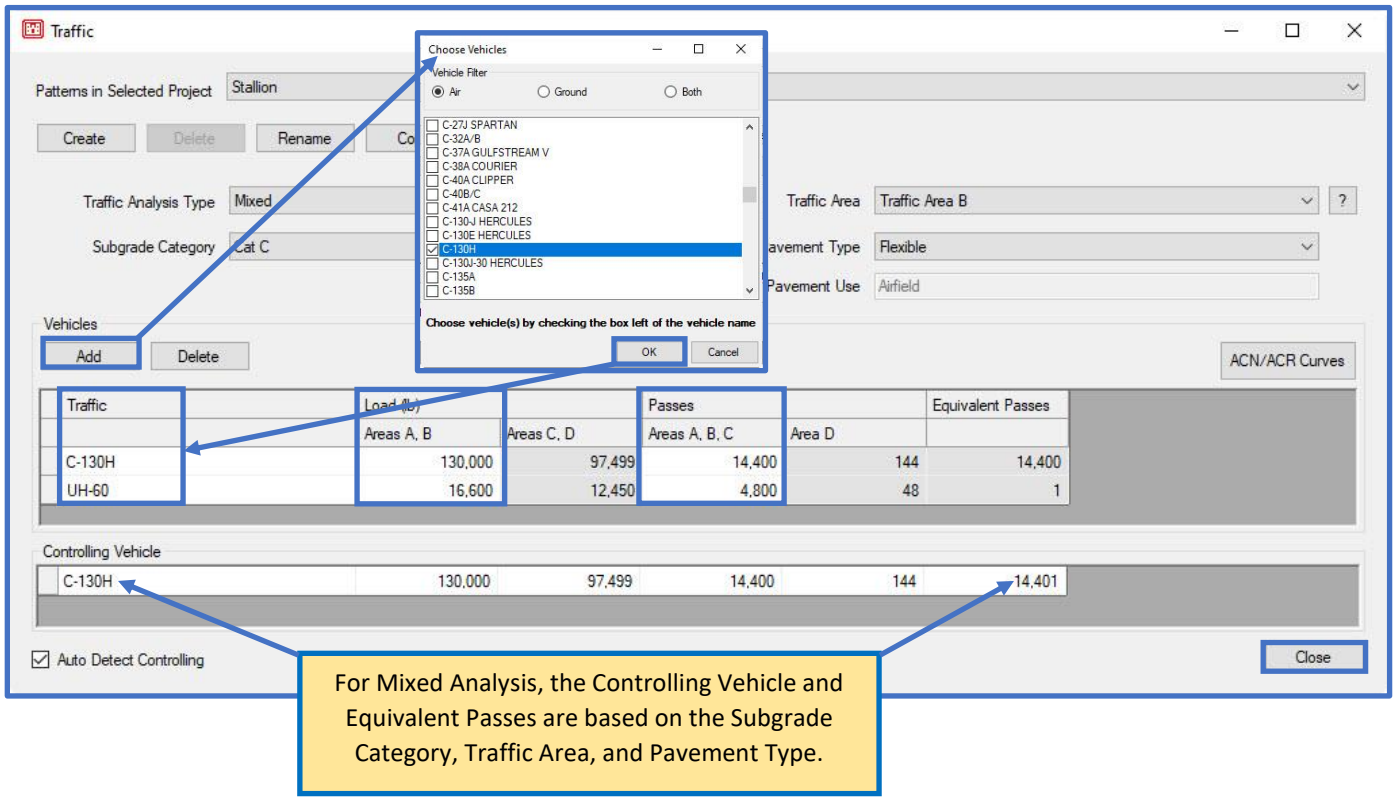
Step 3. Define traffic and settings

- Select Evaluation Manager
  - Use the pulldown for Service and select Army
  - Use the pulldown under Climate and select the appropriate Weather Station *(optional since Frost is not a consideration and FWD data is not being used)*
  - On the Evaluation Manager form, under Default evaluation settings; click on the Default traffic pattern icon 
    - On the Traffic form; select Create
      - Enter a Pattern name
      - Use the pulldown to select the Pavement use
      - Select Ok
    - Under Vehicles select Add
      - Select the appropriate vehicles; then OK upon completion
      - Enter the Load and Passes indicated in Table 3

      Note: On the Traffic form, for a mixed analysis; select the subgrade category (from the DCP analysis), traffic area, and pavement type to display the controlling vehicle and equivalent passes. This is optional, since this process may also be performed in the APE form/analysis.
    - To exit the traffic form; select Close
    - To exit the Evaluation Manager; select Close

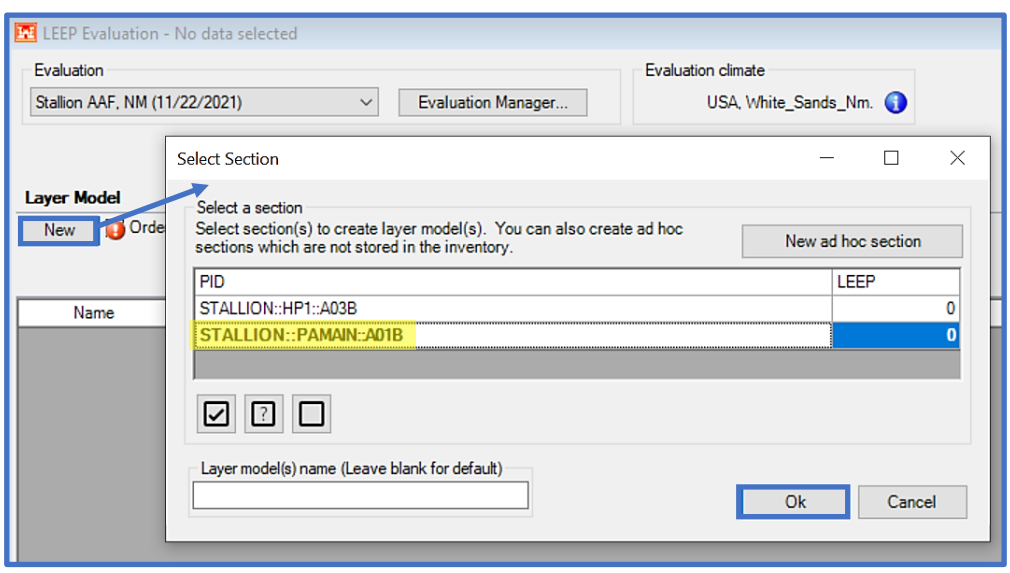

Evaluation Manager
Evaluation
Stallion AAF, NM (11/22/2021)
New
Copy
Rename
Delete
Date
Monday , November 22, 2021
Service
Army
Description
Comments
Climate
Weather station
State or country
USA-New Mexico
Weather station
White_Sands_Nm.
Weather station info
Month Readings...
Temperature settings
Set 5 day mean...
Consider Frost
Default evaluation settings
Default traffic pattern
Stallion
Specify default mission critical aircraft
Calculate overlays
Default APE settings
Analysis
Rigid criteria
First Crack
Use Alpha Criteria
Default LEEP settings
Analysis
Rigid Failure SCI
50
Backcalculation
Set default control parameters...
Thaw Modulus Reduction Method
Use Modulus Reduction Factors
Use FASSI or FAIR Values
Mark as historical
Close


Traffic
Patterns in Selected Project
Create
Import
Standard
Traffic Analysis Type
No Pattern
Pavement Use
Vehicles
Add
Create New Traffic Pattern
Pattern Name
Stallion AAF
Pavement Use
Airfield
OK
Cancel
ACN/ACR Curves
Close

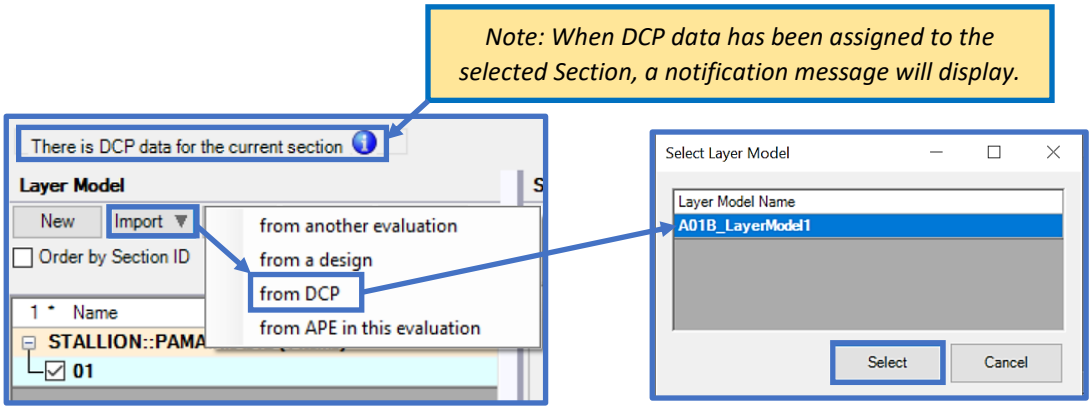


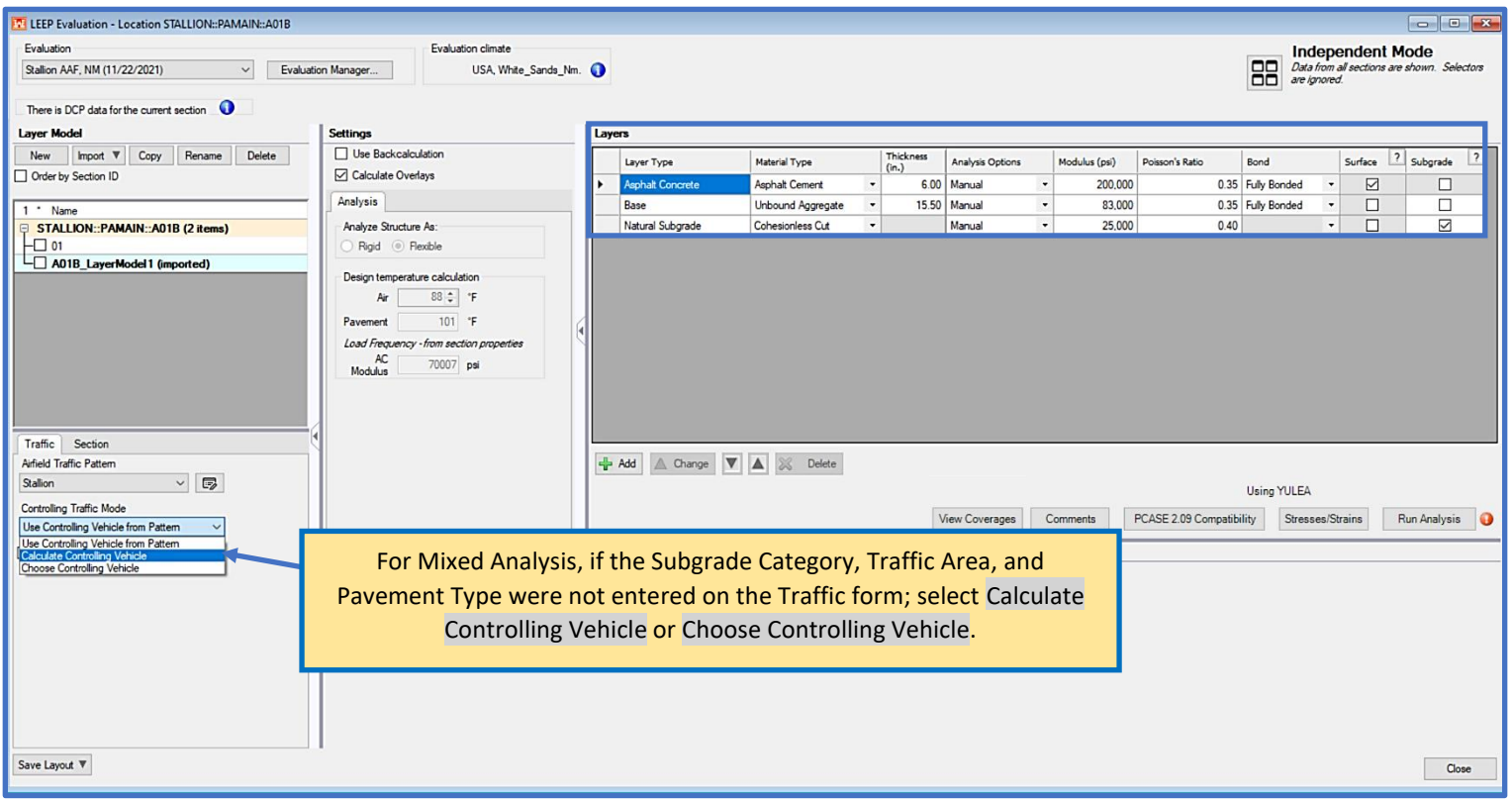
Step 4. Import DCP data

- On the LEEP evaluation form, under Layer Model; select New
  - On the Select Section form; select STALLION::PAMAIN::A01B
  - Select Ok to exit the Select Section form



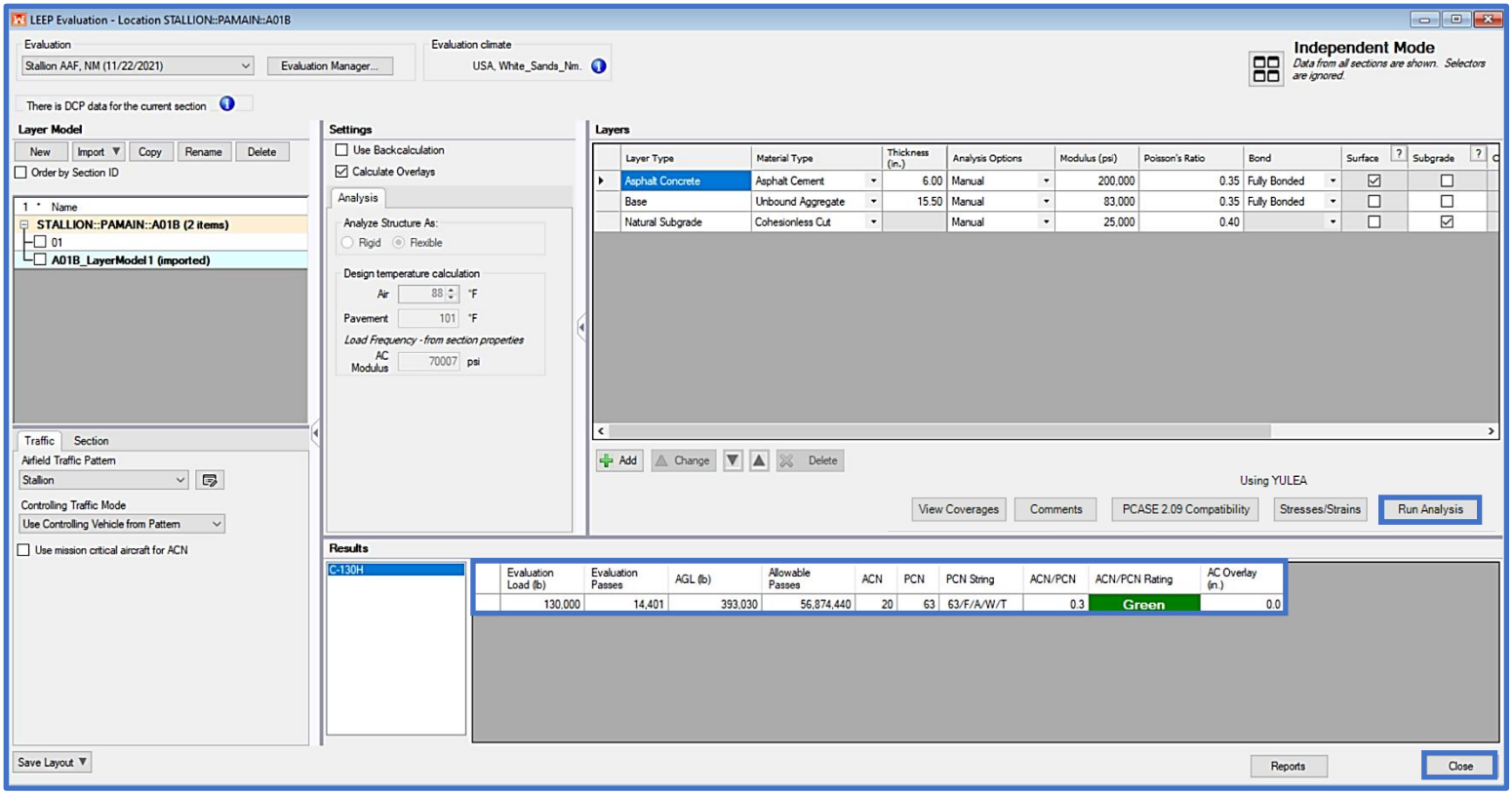
- On the LEEP evaluation form, under Layer Model
  - Use the Import pulldown to select from DCP
- On the Select Layer Model form
  - Select A01B_LayerModel1
  - Click on Select to exit the form
- The DCP layer model is imported and displayed in Layers





Step 5. Run Analysis

- To complete the analysis; select Run Analysis
- Results are displayed in the Results grid
- To exit LEEP; select Close



13.3.3 Evaluate pavements using backcalculated modulus values

Evaluate the pavement Section R01A, Branch RW1432, at Stallion AAF, using the FWD results from example 15.3.1 Perform Analysis of Pavement Using Deflection Basin Data and the parameters provided in Table 4.

Table 4.			
Stallion AAF, White Sands, NM (Service – Army)			
RW1432, Section R01A Evaluation date – 06/26/2019 Surface pavement – Satisfactory condition (PCI=82; load distress=32%) Evaluate for Stallion traffic pattern (see Example 13.3.2) and Air Force 14 Groups New Frost is not a consideration Calculate overlays			
Layer Type	**Material Type**	**Thickness In. (mm)**	**Modulus psi (MPa)**
AC Overlay	Asphalt Cement	3 (76.2)	
Asphalt Cement	Asphalt Cement	2 (50.8)	*
Base	Unbound Aggregate	8 (203.2)	*
Natural Subgrade	Cohesive cut	227 (5,765.8)	*
Bedrock	Bedrock	--	--
* Modulus values backcalculated from FWD data explained in Example 15.3.1			

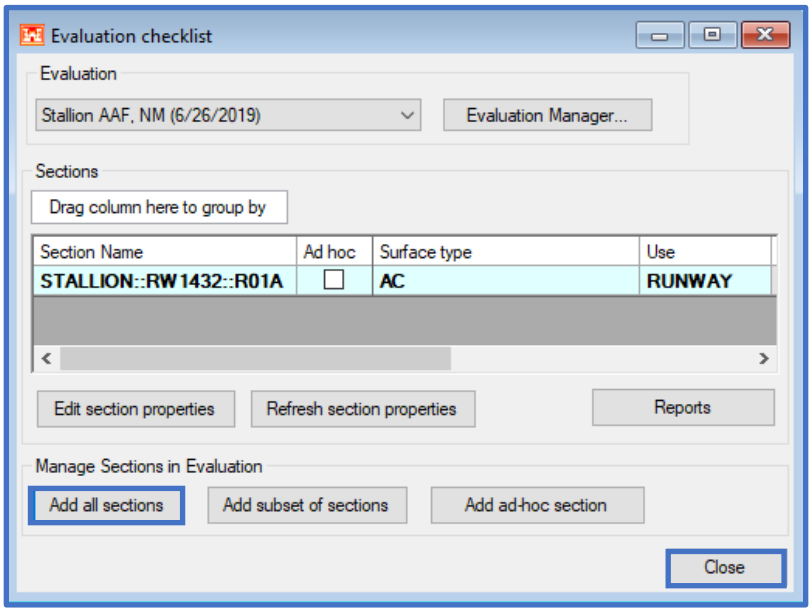
In Example 15.3.1 Step 11, all of the .FWD deflections (for all stations) of Drop 3 were assigned to Section R01A. Perform the following steps to complete the evaluation analysis.

Step 1. Use a previously imported data or create a new database – reference Chapter 2 File Menu, Section 2.1.1 New/import pavement database.

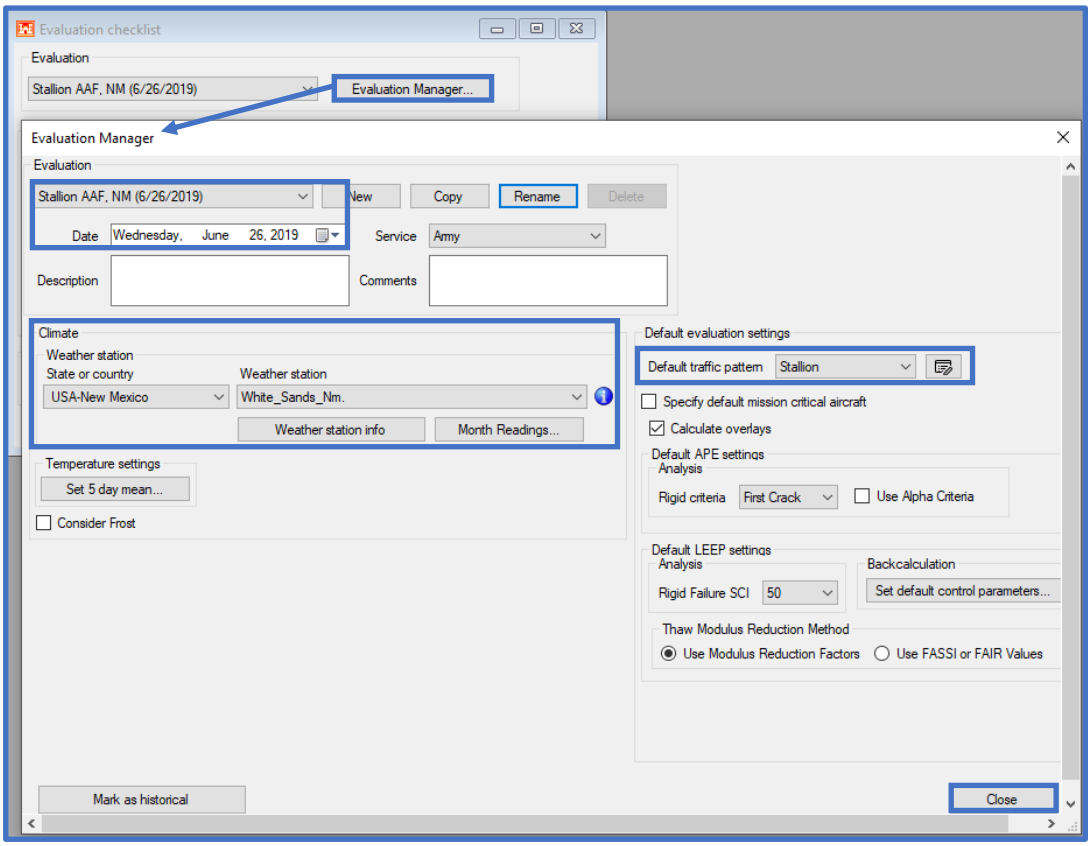
Step 2. Verify existing or create a new pavement section Inventory (Network: Stallion; Branch: RW1432; Section: R01A) – reference Chapter 2 File Menu, Section 2.14 PCASE Data Assignment.

Step 3. Evaluation Checklist

- Open Evaluation Checklist
- In Evaluation checklist; select Add all sections to add R01A.
- Select Close to exit.

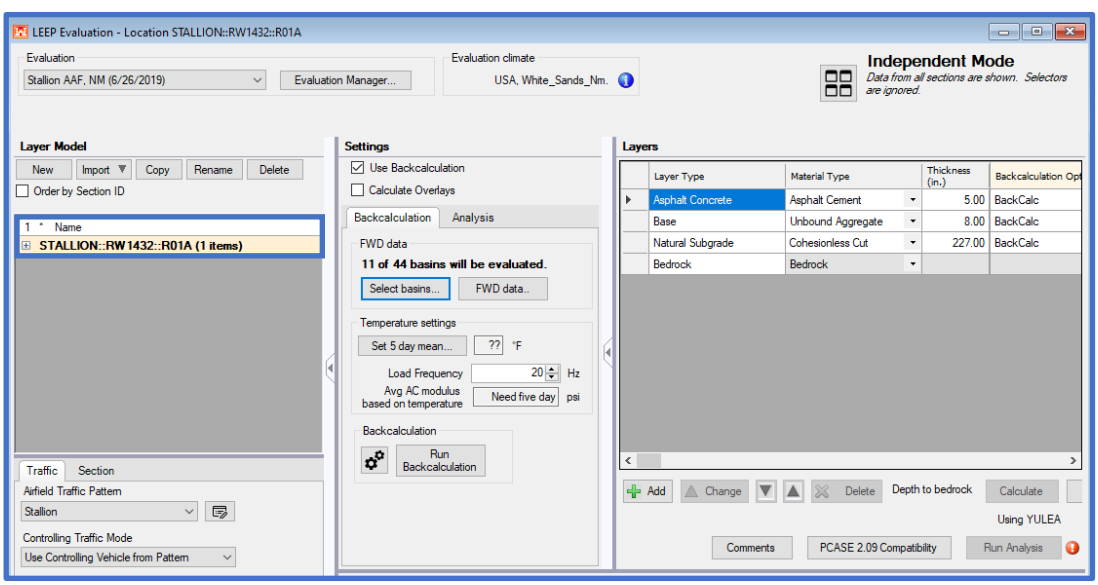


- Select Evaluation Manager
- Verify the evaluation parameters (i.e., Evaluation Name, Date, Traffic, Calculate Overlays, Climate data, Backcalculation Control Parameters). Change where needed; reference Chapter 12 Evaluation Checklist, Section 12.3 Evaluation Manager.
- Select Close to exit.

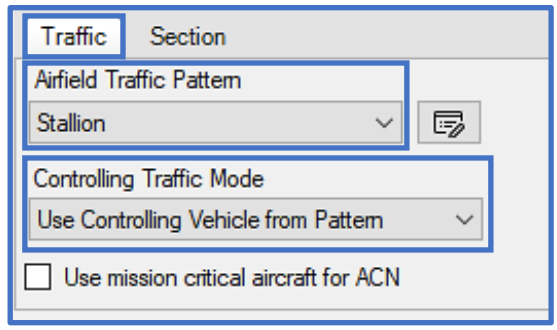


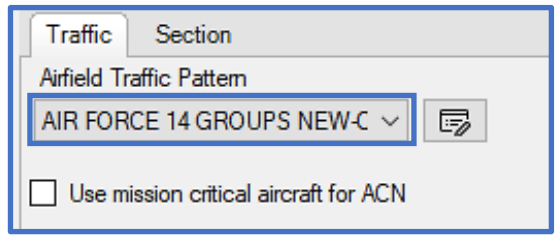
Step 4. LEEP evaluation

- Open LEEP and verify that R01A was added to the evaluation.

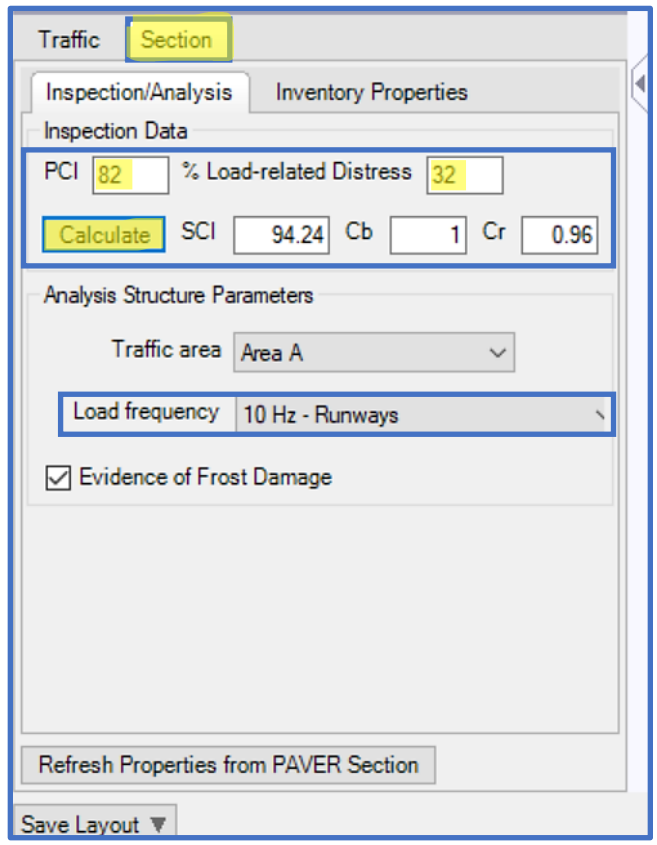


- Verify Traffic by selecting the Traffic tab. There should be 2 patterns available in the Airfield Traffic Pattern pulldown.
  - Stallion mixed traffic pattern should be available. For the Controlling Traffic Mode, select Calculate Controlling Vehicle.
  - Verify that Air Force 14 Groups New is also available. Since this is an individual pattern, the controlling vehicle and equivalent passes are not calculated.

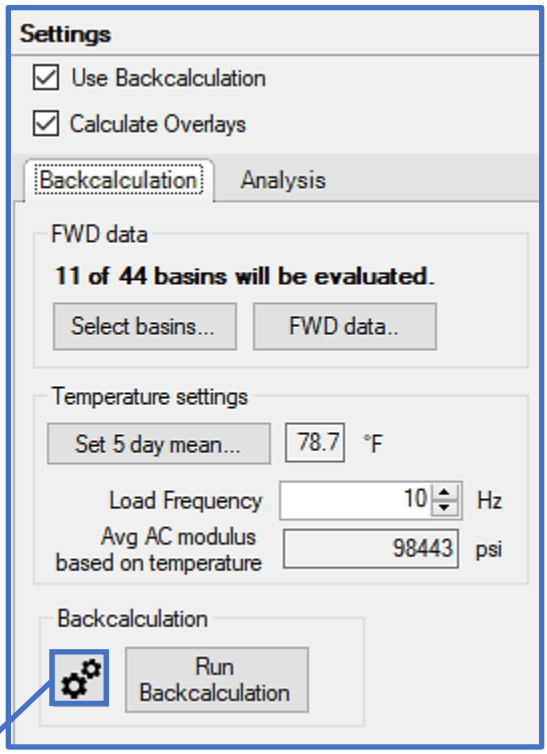


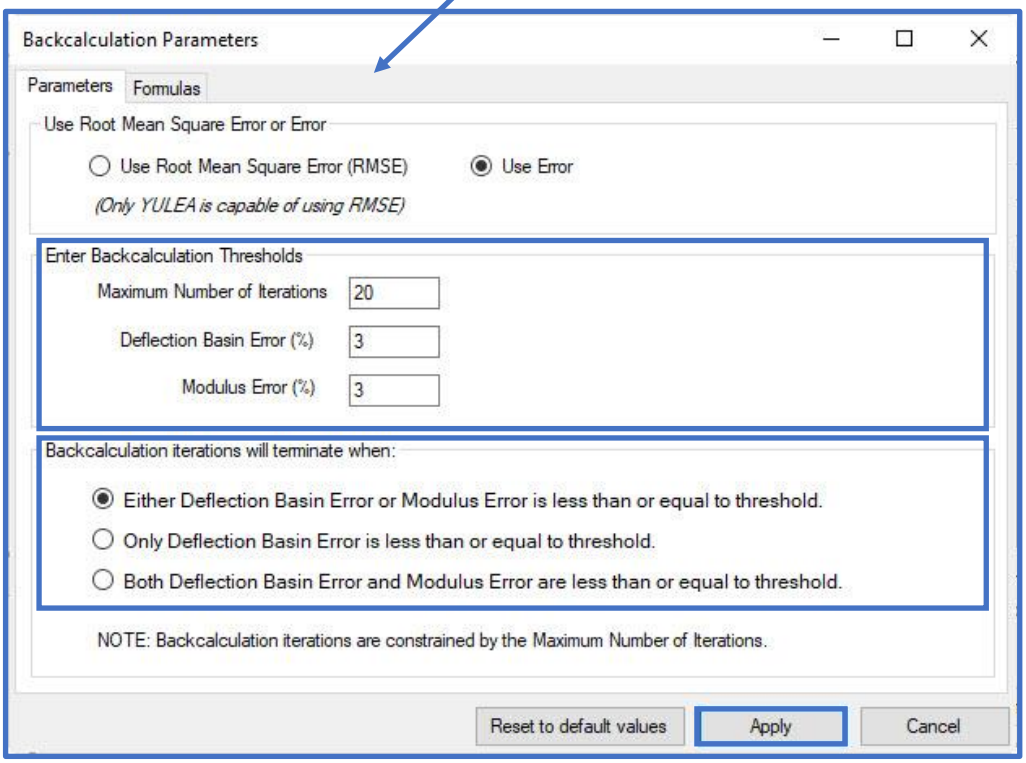


- Check Section information by selecting the Section tab
  - Edit the PCI, % Load-related Distress for overlay coefficient calculation
  - Select the applicable Load Frequency in the case that Analysis Option: Temperature will be selected during evaluation. This section is part of a runway, so Load Frequency: 10- Runways will be selected.

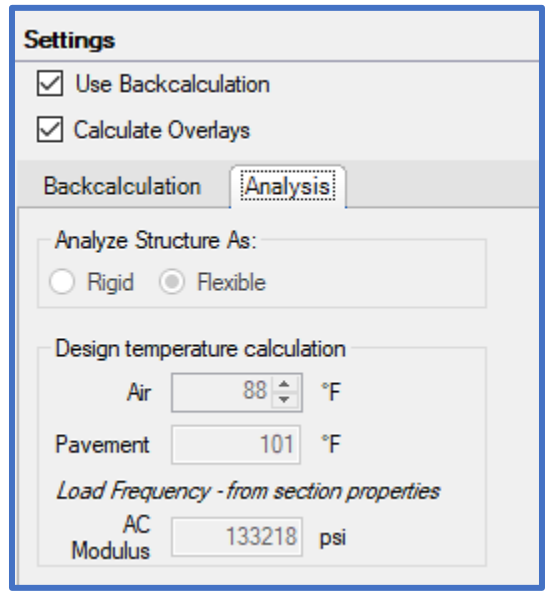


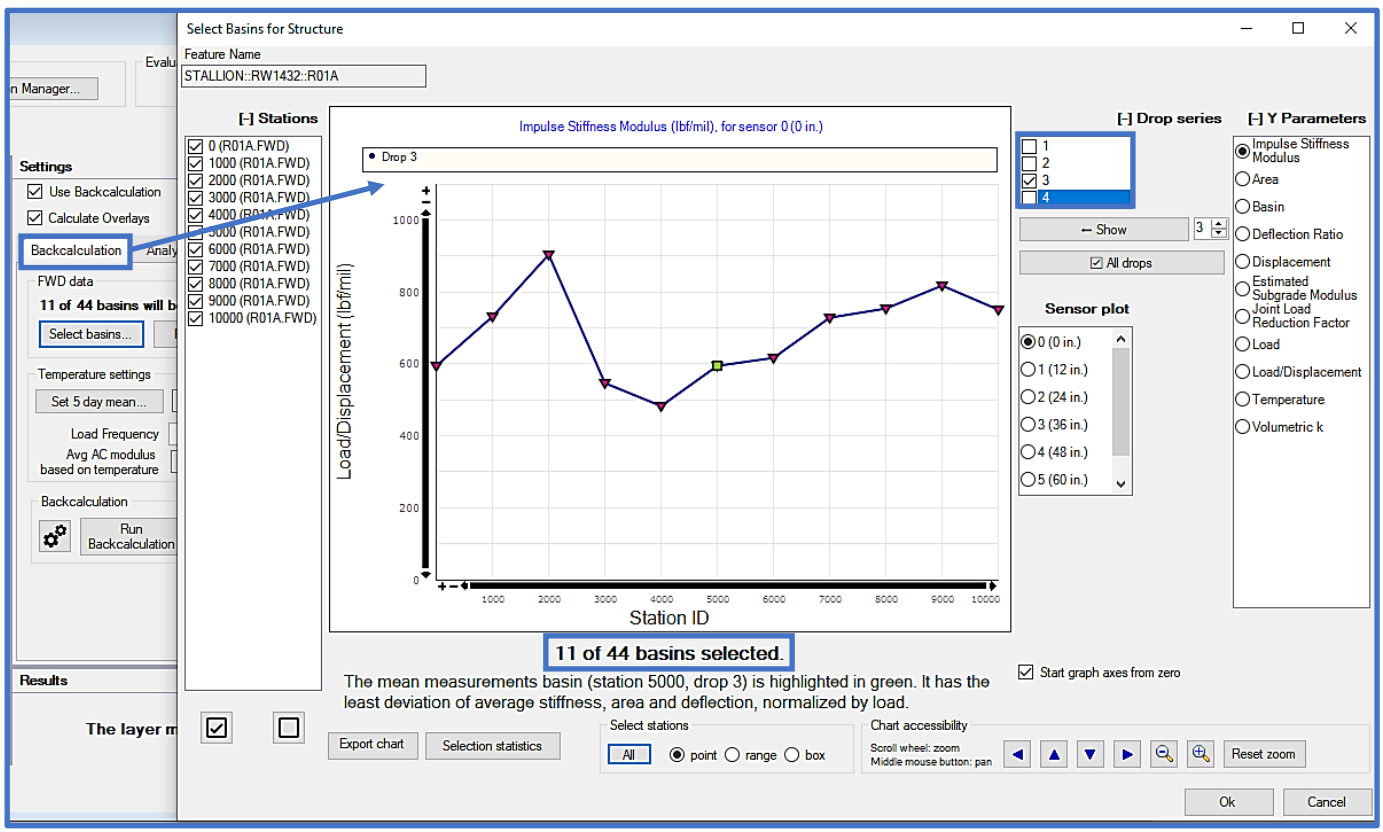
- In Settings
  - Check the box for Use Backcalculation
  - Check the box for Calculate Overlays
  - In the case that the Backcalculation Option: Temperature (avg) or Temperature (per drop) may be used during backcalculation, then enter the temperature data under Set 5 day mean…This section is part of the runway, so Load Frequency 10 Hz will be selected.
  - Open the Backcalculation Settings form. Select the default values for all Parameter thresholds. Select Apply and close the form.



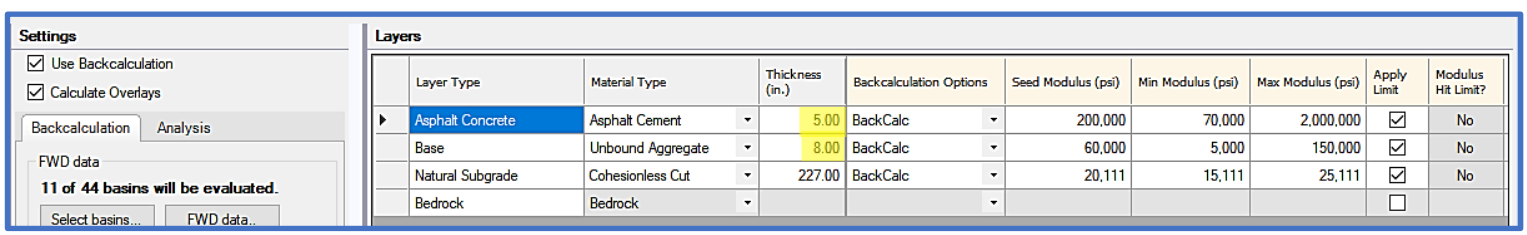


- Proceed to the Analysis tab and review the calculated AC Modulus in the case that Analysis Option: Temperature is selected for evaluation.
- Return to the Backcalculation tab
  - Select Select basins…
    - On the Select Basins for Structure form, turn off (deselect) Drop series 1, 2, and 4. Next, select All under Select stations.
    - The form now displays "11 of 44 basins selected."
    - Select Ok



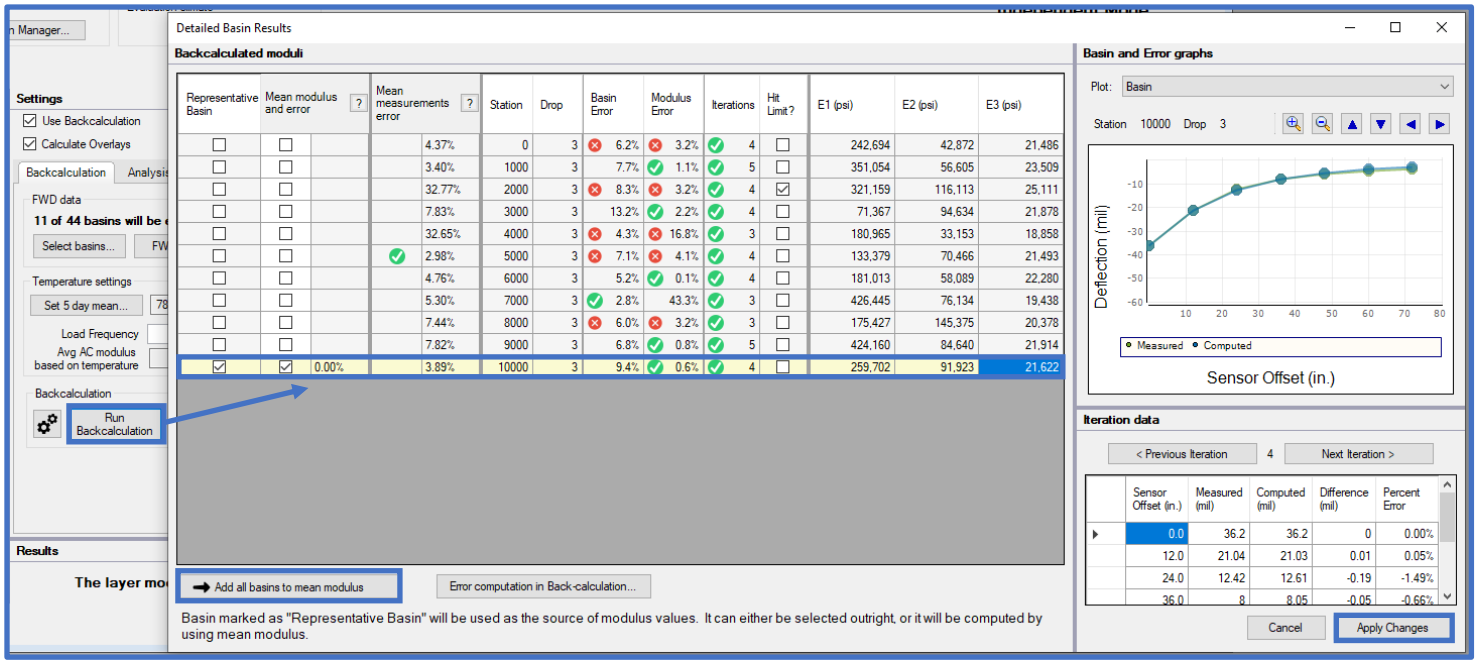


- Within the Layers section of the form, verify the Layer Type and Material Type and enter the Thickness for each layer.
- Under Backcalculation Options, verify Back Calc is selected for each layer in the structure. This signifies that the backcalculation computational routine will be used for all layers.
- Review and modify Seed Modulus, Min Modulus, and Max Modulus for all layers, per engineering judgement. For this example, the default values will be employed.
- Make selection for Apply Limit criteria. For this example, the default selection for all layers will be used.
- Modulus Hit Limit? and Backcalculated Modulus are output fields. These will be reviewed after the backcalculation is completed.
- For Analysis Options, ensure BackCalc is selected for all layers. The backcalculated values obtained from the computation routine will be transposed to the Modulus field for use during analysis to obtain the final results (e.g., AGL, Allowable Passes, etc.).
- Review the Poisson's Ratio values. For this example, the default values will be used.
- Select the Bond condition. This is flexible pavement, so the default Fully Bonded option will be used for all layers.
- Review and verify the Surface and Subgrade analysis criteria. For this example, the default selections will be used. Controlling Criteria is an output field and will be reviewed after the analysis is completed.



Layer Type	Material Type	Thickness (in.)	Backcalculation Options	Seed Modulus (psi)	Min Modulus (psi)	Max Modulus (psi)	Apply Limit	Modulus Hit Limit?
Asphalt Concrete	Asphalt Cement	5.00	BackCalc	200,000	70,000	2,000,000	☑	No
Base	Unbound Aggregate	8.00	BackCalc	60,000	5,000	150,000	☑	No
Natural Subgrade	Cohesionless Cut	227.00	BackCalc	20,111	15,111	25,111	☑	No
Bedrock	Bedrock						☐	

- At this point, all applicable and necessary information required of a backcalculation is complete. On the Backcalculation tab select Run Backcalculation.
- Select Add all basins to mean modulus. The backcalculation routine identified the last station as the Representative Basin. For this example, the engineer will use these backcalculated results for the analysis. The backcalculated results identified are E1: 259,702 psi, E2: 91,923 psi, E3: 21,622 psi. Select Apply Changes.



Representative Basin	Mean modulus and error		Mean measurements error	Station	Drop	Basin Error	Modulus Error	Iterations	Hit Limit?	E1 (psi)	E2 (psi)	E3 (psi)
☐	☐		4.37%	0	3	6.2%	3.2%	4	☐	242,694	42,872	21,486
☐	☐		3.40%	1000	3	7.7%	1.1%	5	☐	351,054	56,605	23,509
☐	☐		32.77%	2000	3	8.3%	3.2%	4	☑	321,159	116,113	25,111
☐	☐		7.83%	3000	3	13.2%	2.2%	4	☐	71,367	94,634	21,878
☐	☐		32.65%	4000	3	4.3%	16.8%	3	☐	180,965	33,153	18,858
☐	☐		2.98%	5000	3	7.1%	4.1%	4	☐	133,379	70,466	21,493
☐	☐		4.76%	6000	3	5.2%	0.1%	4	☐	181,013	58,089	22,280
☐	☐		5.30%	7000	3	2.8%	43.3%	3	☐	426,445	76,134	19,438
☐	☐		7.44%	8000	3	6.0%	3.2%	3	☐	175,427	145,375	20,378
☐	☐		7.82%	9000	3	6.8%	0.8%	5	☐	424,160	84,640	21,914
☑	☑	0.00%	3.89%	10000	3	9.4%	0.6%	4	☐	259,702	91,923	21,622

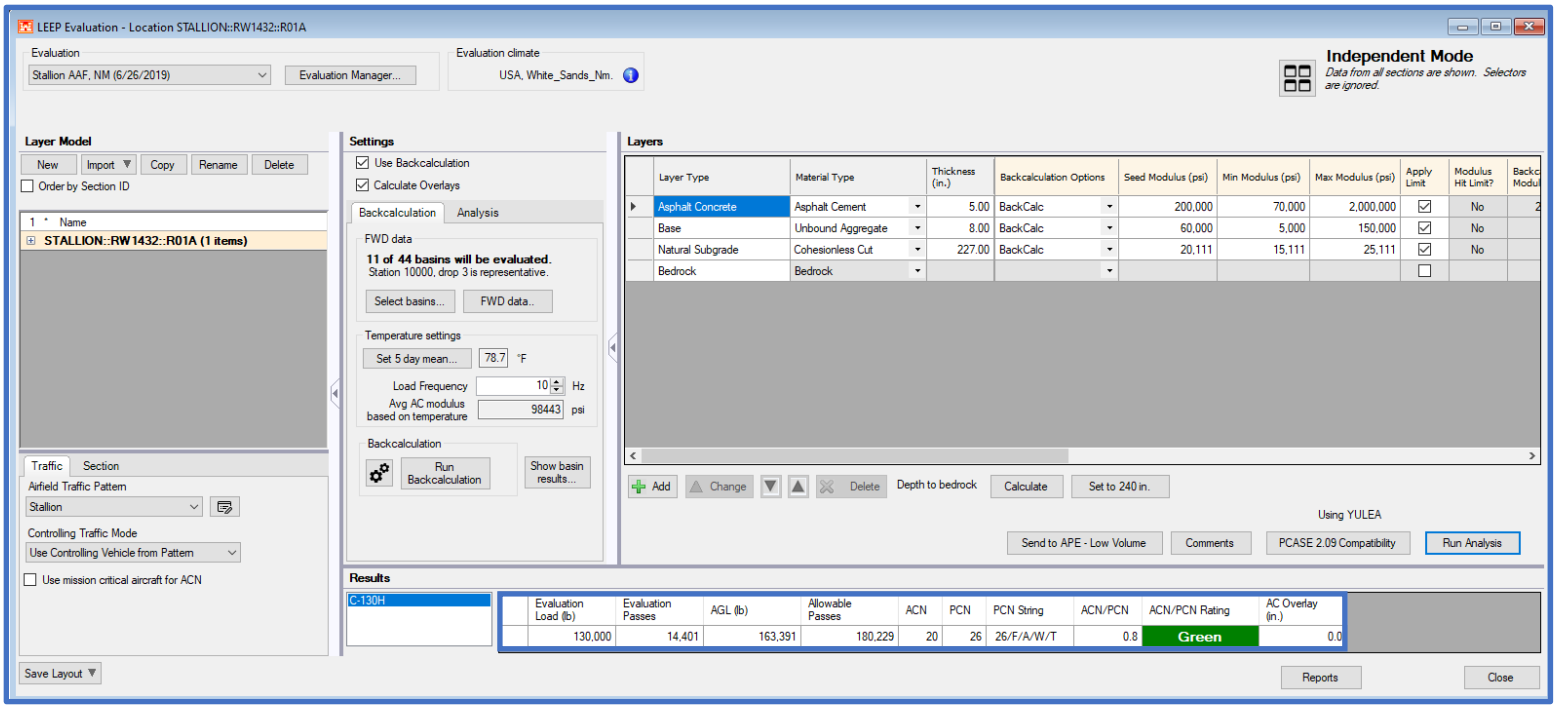
Sensor Offset (in.)	Measured (mil)	Computed (mil)	Difference (mil)	Percent Error
0.0	36.2	36.2	0	0.00%
12.0	21.04	21.03	0.01	0.05%
24.0	12.42	12.61	-0.19	-1.49%
36.0	8	8.05	-0.05	-0.66%

- Under the Layers sub-form, the backcalculation output fields are now populated. The Backcalculated Modulus and Modulus fields reflect the moduli values selected (in this case, from the Representative Basin) after the backcalculation routine. The Modulus Hit Limit? field shows that no limits were met or exceeded during backcalculation of this specific basin.

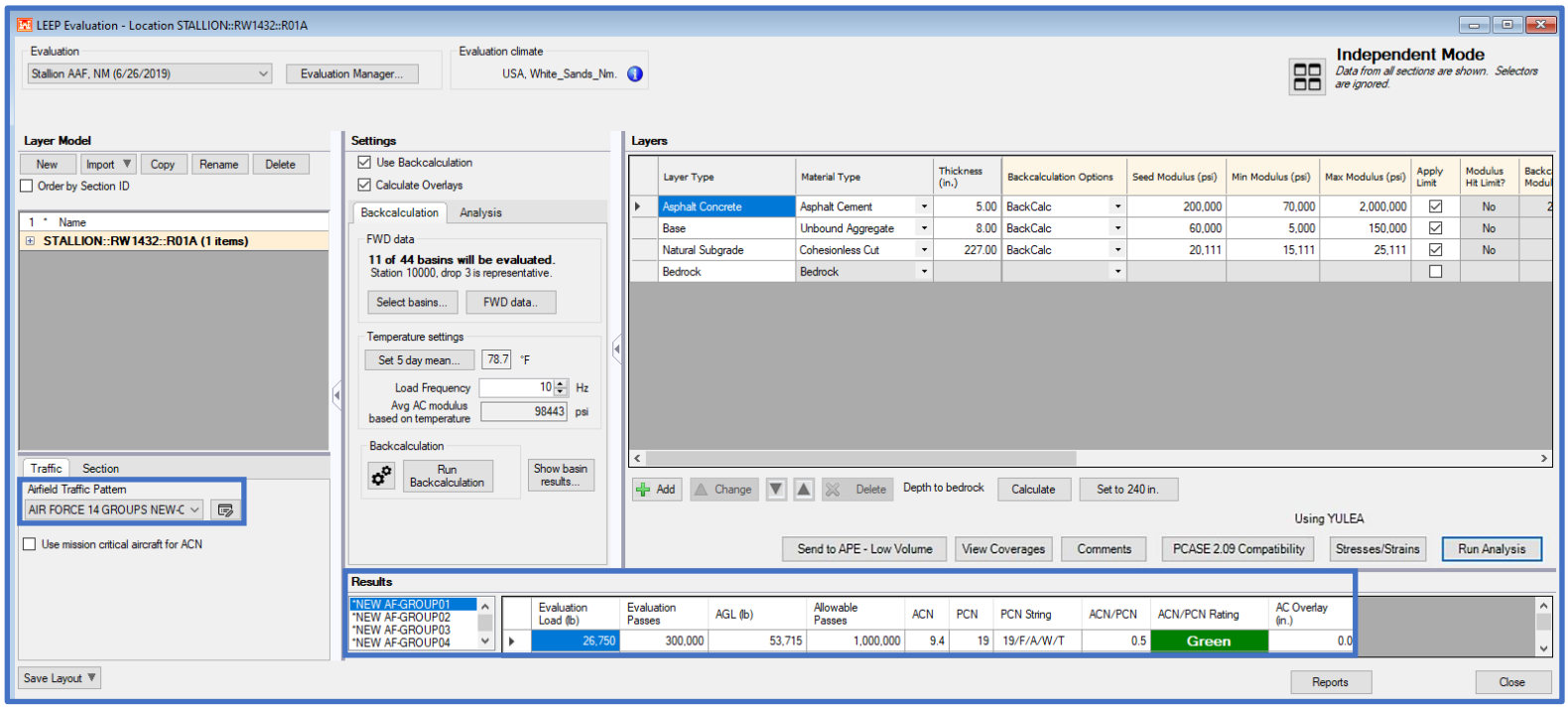
Layers

Layer Type	Material Type	Thickness (in.)	Modulus Hit Limit?	Backcalculated Modulus (psi)	Analysis Options	Modulus (psi)	Poisson's Ratio	Bond	Surface	Subgrade	Control
Asphalt Concrete	Asphalt Cement	5.00	No	259,702	BackC...	259,702	0.35	Fully...	☑	☐	
Base	Unbound Aggregate	8.00	No	91,923	BackC...	91,923	0.35	Fully...	☐	☐	
Natural Subgrade	Cohesionless Cut	227.00	No	21,622	BackC...	21,622	0.40	Fully...	☐	☑	
Bedrock	Bedrock					1,000,000	0.50		☐	☐	

- At this point, all necessary and applicable parameters are populated for a complete analysis. Select Run Analysis to obtain output for the Airfield Traffic Pattern: Stallion. Results are displayed in the Results sub-form. The subgrade is shown to be the Controlling Criteria layer.



- Finally, change the Airfield Traffic Pattern to Air Force 14 Groups New. Select Run Analysis. Results are displayed in the Results sub-form. The subgrade is shown to be the Controlling Criteria layer.



14 APE Evaluation

APE Evaluation is capable of analyzing pavements using the empirical method producing resultant allowable loads, passes, Pavement Classification Numbers (PCN), and overlay requirements.

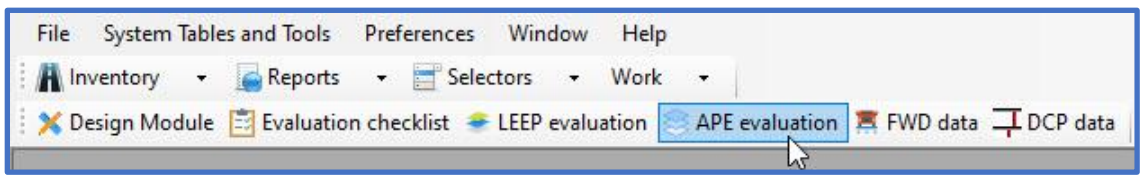
Prior to beginning a new evaluation, ensure that you have opened or created a database to store the evaluation within (database name is displayed on the bottom-left of the main window). For instructions on how to import or create a database; reference Chapter 2 File Menu.

Prior to using APE evaluation, ensure you have defined your inventory (unless you will be creating sections Ad Hoc); reference the Define Inventory help file.

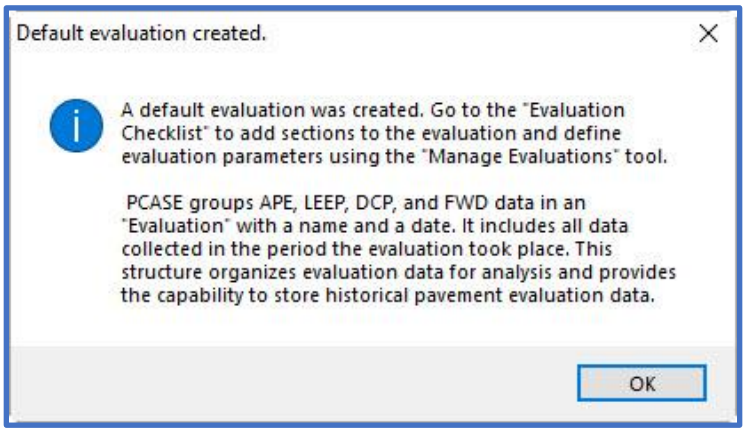
The asset inventory should be initialized prior to using the APE evaluation form; reference Chapter 12 Evaluation checklist.

14.1 Getting Started

Select APE evaluation on the PCASE 7 tool bar to open the Airfield Pavement Evaluation (APE) tool.

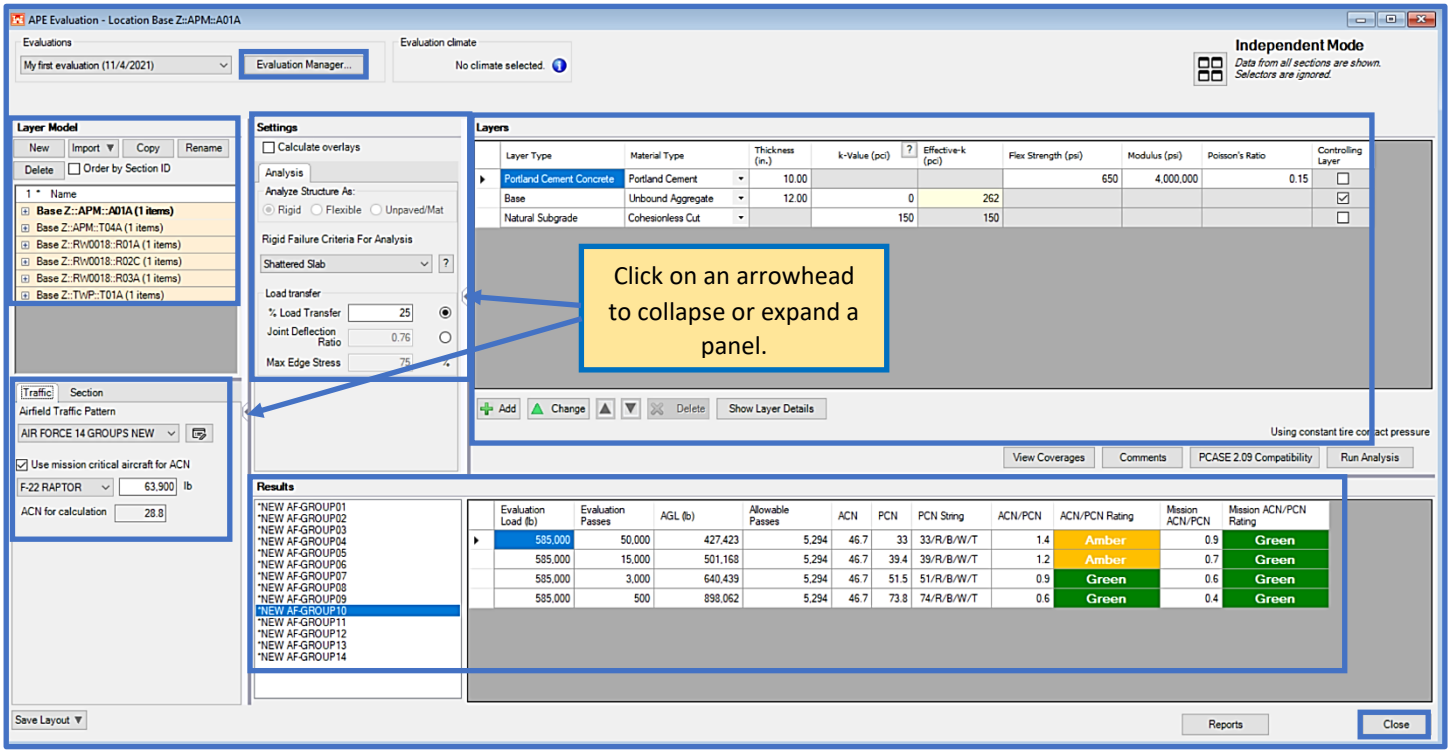


If you have not imported or created an evaluation in the current database, the message below pops up indicating a default evaluation was created. Click OK to continue and open the APE evaluation.



14.2 APE Evaluation form

The APE evaluation form is displayed below. To run an APE evaluation, you will go through various sub-sections of the form to modify the default analysis conditions, if desired. The sub-sections are Evaluation Manager, Layer Model, Traffic and Sections, Settings, and Layers. The analysis output results are displayed within Results. Select Close to exit APE evaluation.

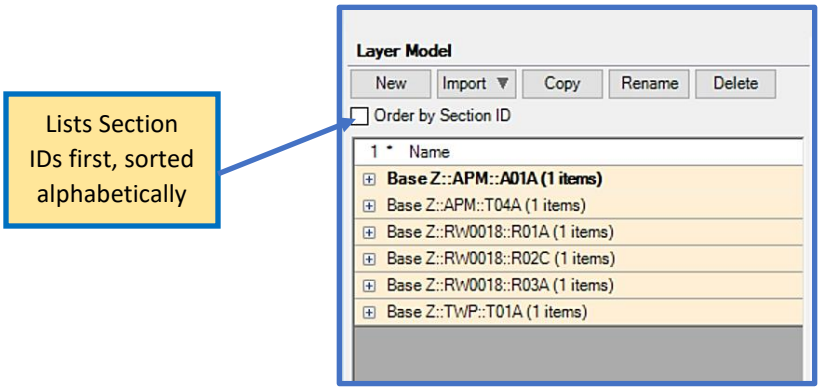


14.2.1 Evaluation Manager

Evaluation Manager serves to establish global analysis parameters. To navigate Evaluation Manager; reference Chapter 12 Evaluation Checklist, Section 12.3 Evaluation Manager.

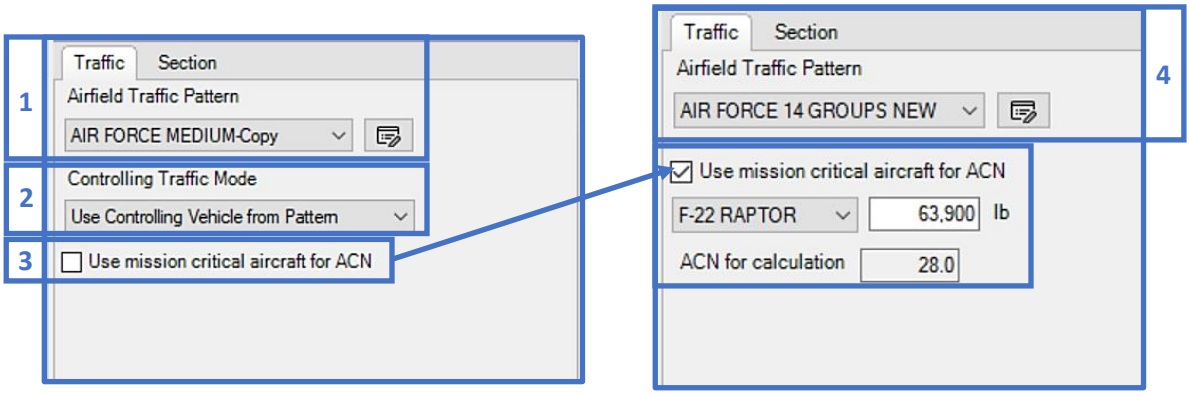
14.2.2 Layer Model

The Layer Model grid populates default pavement structures that may be modified and results for the selected Section of an APE evaluation in the lower grid. Multiple layer models, each with distinct, user-specified analysis conditions and results, can exist for a given Section of an Evaluation. To create a new model (ad hoc section), select New. To Import a model from another evaluation, a design, or DCP, select Import. The layer model must be within the current database. To copy an existing model and all the associated analysis conditions and results, select a model then select Copy. Select Rename to edit the default name. To delete a model replicate, select the model, then select Delete.



14.2.3 Traffic tab

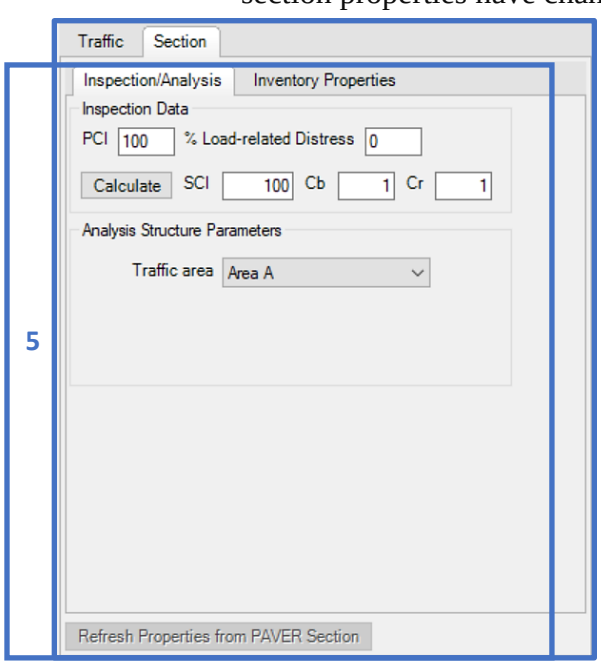
1. Traffic patterns defined within Evaluation Manager are available for selection in all evaluations. An existing traffic pattern can be selected from the dropdown or a new traffic pattern can be created by selecting the icon.
2. If a Mixed Traffic Analysis Type is selected, the options for Controlling Traffic Mode are: Use Controlling Vehicle from Pattern, Calculate Controlling Vehicle and Choose Controlling Vehicle. Use Controlling Vehicle from Pattern will utilize the loading and equivalent passes of the Controlling Vehicle defined within the Traffic Pattern form. This is based on the Traffic Area, Subgrade Category, and Pavement Type. Calculate Controlling Vehicle will recalculate the loading and equivalent passes of the Controlling Vehicle based on the Traffic Area selected in the Section Properties sub-section, and the Subgrade Category associated with the CBR value of the subgrade within the Layers sub-section. Choose Controlling Vehicle allows you to choose which vehicle in the mix controls.
3. In addition to calculating the ACN and PCN for the traffic in the selected pattern, Use mission critical aircraft for ACN allows you to select an additional aircraft for analysis.
4. If an Individual traffic pattern is selected, the options for Controlling Traffic Mode are not displayed.

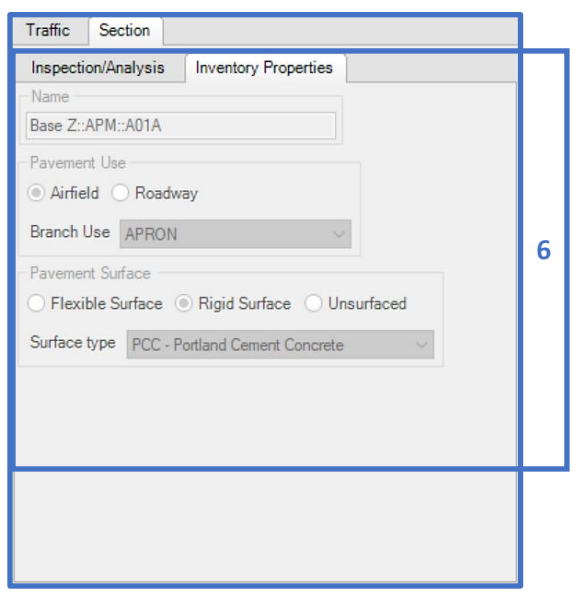


14.2.4 Section tab

5. The Inspection/Analysis tab displays the Pavement Condition Index (PCI), % Load-related Distress, SCI and C_b and C_r , and Evidence of Frost Damage (if applicable) extracted from Define Inventory and Evaluation Manager.
   - In Inspection Data, enter the PCI and % Load-related Distress resulting in the SCI, Cb and Cr. A Condition PCI ≤ 40 will activate a load reduction in the Allowable Gross Load (AGL) and an increase in gross weight. The calculated SCI will yield condition factors Cb and Cr that impact the recommended overlay thickness results for rigid pavements.
   - Analysis Structure Parameters displays options for Traffic area, and Evidence of Frost Damage. Use the drop-list to select the appropriate Traffic area (Area A, B, C, or D). Check the box for Evidence of Frost Damage to enable Depth of Frost, FASSI or FAIR values, Frost Code, Moisture Content, and Dry Unit Weight. These inputs directly impact the Results by including results for Frost conditions.

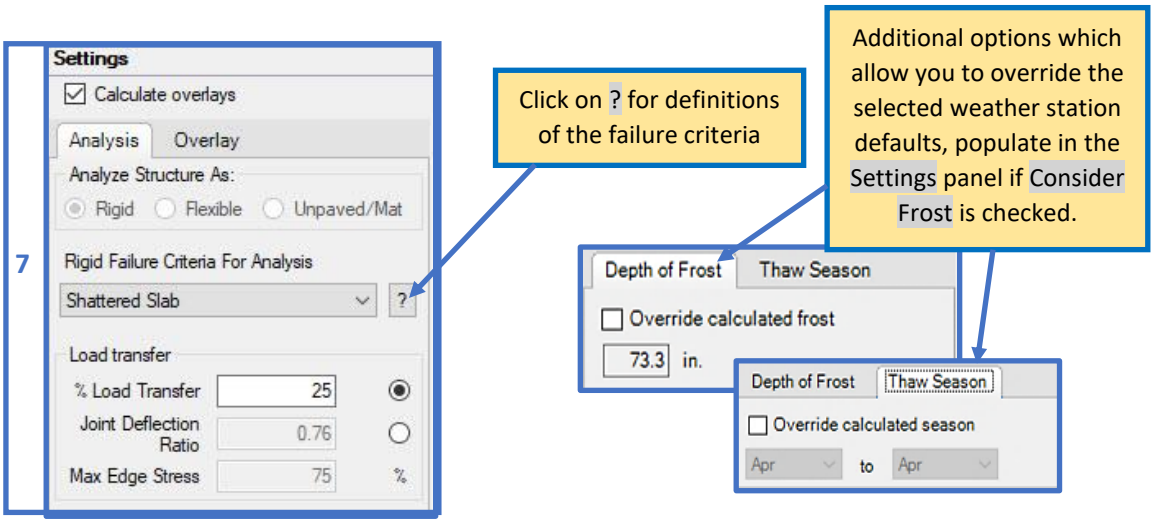
6. The Inventory Properties tab displays characteristics of the section, as defined in the Network Inventory. *Note: The fields in this tab are only editable for ad hoc sections.* These characteristics consist of:
   - Name
   - Pavement Use
     - Airfield or Roadway
     - Branch Use (Runway, Taxiway, Roadway, Parking area, etc.)
   - Pavement Surface
     - Flexible Surface, Rigid Surface, or Unsurfaced
     - Surface Type
   - Refresh properties from PAVER section becomes enabled once inventory section properties have changed.





14.2.5 Settings

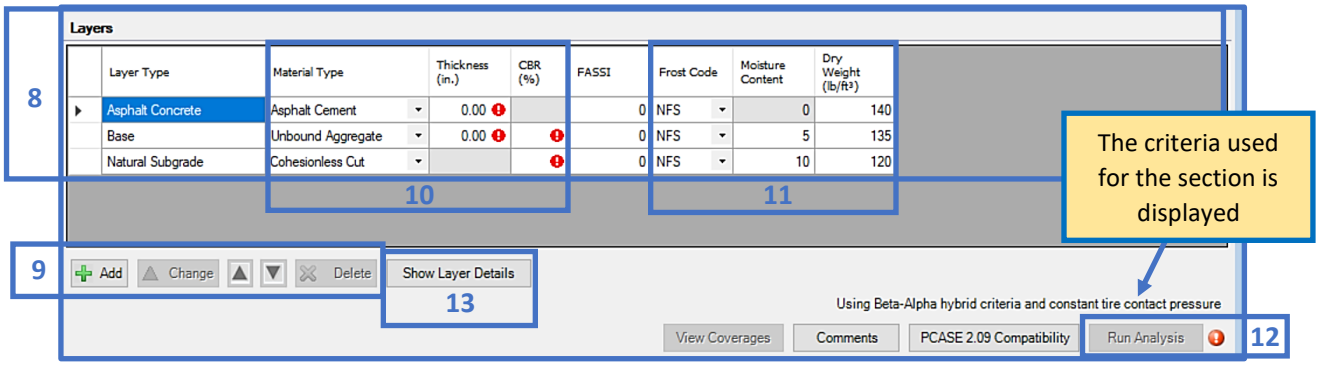
7. Settings comprises of Calculate overlays, Analyze Structure as, Rigid Failure Criteria For Analysis and Load transfer (rigid pavement only).
   - Check the Calculate overlays box to display overlays in Results for pavements that cannot support the assigned traffic. Select the Overlay tab (PCC pavements only) to display the SCI, Cb, and Cr calculated on the Inspection/Analysis tab. The PCC Overlay Flex strength and Modulus values may be edited in this section.
   - Analyze Structure as displays the pavement surface (Rigid, Flexible, Unpaved/Mat) extracted from Define Inventory.
   - Rigid Failure Criteria For Analysis allows you to set the failure criteria (First Crack, Shattered Slab, Complete Failure).
   - Use the Load transfer (rigid pavement only) options; Percent Load Transfer or Joint Deflection Ratio to change the Max Edge Stress. The defaults are set for a rigid pavement with good load transfer. Increasing the Max Edge Stress results in lower Allowable Gross Loads (AGL) and allowable passes.



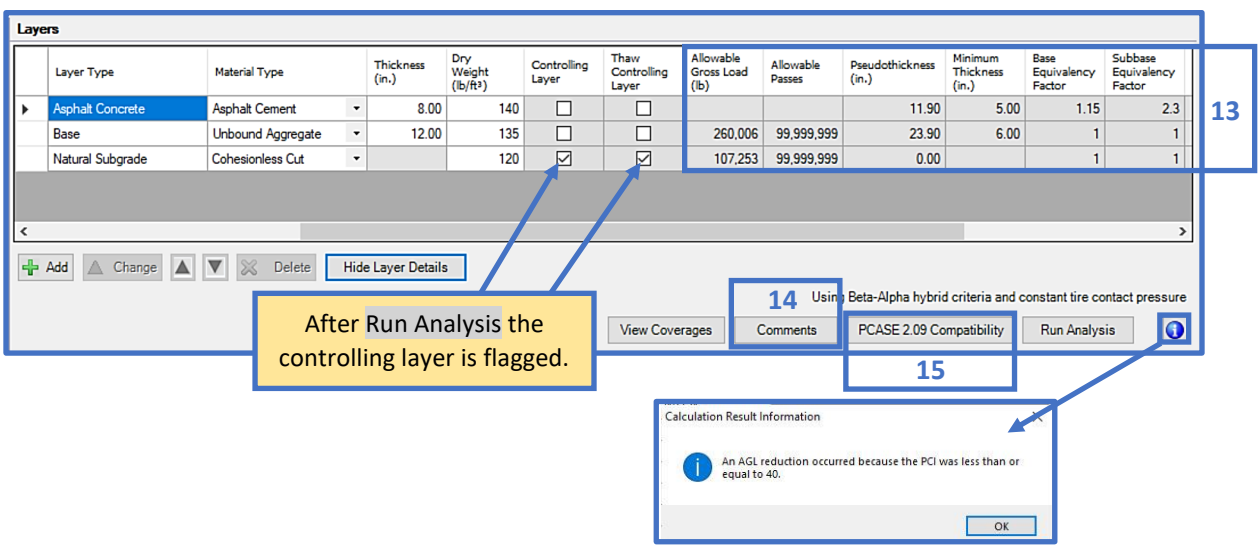
14.2.6 Layers

8. The Layers grid populates a default structure for the pavement type. Pavement types available in APE are Rigid, Flexible and Unpaved/Mat.
9. Layers and their coinciding material types can be added or edited using the Add or Change buttons beneath the layer grid. To Add a layer, select the Layer Category and the respective Material Type. The Change layer button becomes enabled when the selected layer can be modified. The Up and Down arrows enable when the selected layer can be moved. The Delete button becomes enabled when a removable layer is selected.
10. For the Flexible Pavement displayed below, select the appropriate Material Type and enter the Thickness and CBR where required.
11. For frost analysis, select the appropriate Frost Code and edit the Moisture Content and Dry Weight as needed.

12. After Run Analysis, the FASSI (frost analysis only), Allowable Gross Load, Allowable Passes are displayed for each layer and the Controlling Layer gets flagged.
13. Select Show Layer Details to display the Pseudothickness, Minimum Thickness, Base Equivalency Factors, Subbase Equivalency Factors, Extra Asphalt, Extra Base, and Equivalency Factor.

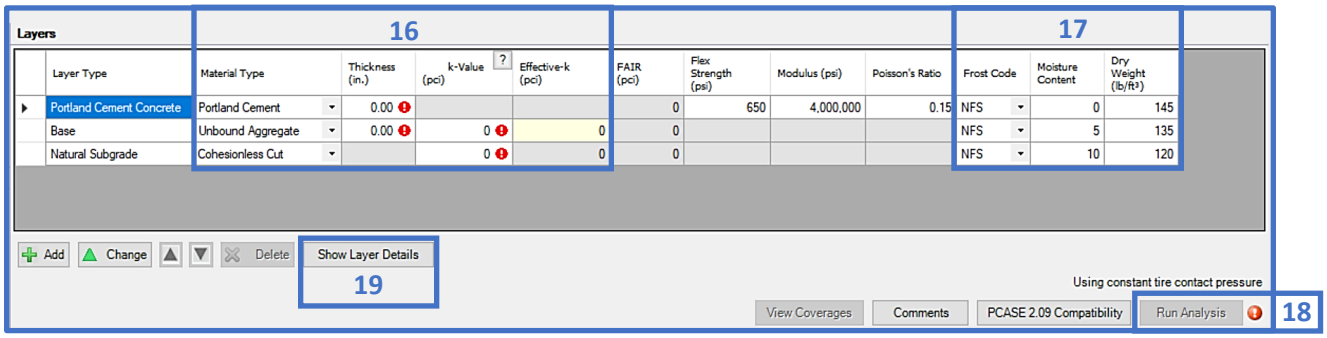


14. Select the Comments button to add notes on the analysis.
15. Select PCASE 2.09 Compatibility to change the CBR Criteria (flexible pavement only) to Alpha and /or the Tire Contact Option to Assume Constant Tire Contact Area. Click the ? button for details of the options.

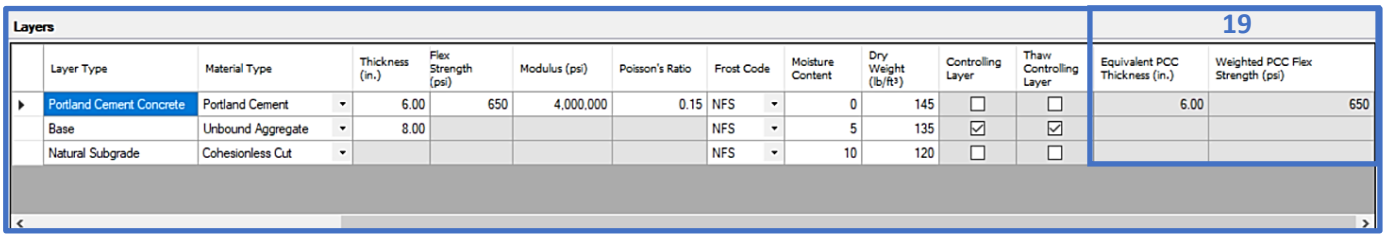


16. For a Rigid Pavement select the appropriate Material Type and enter the layer Thickness and K-Value, where required. The Effective K is calculated or can also be entered if known. Edit the Flexural Strength (concrete), Modulus (concrete and stabilized base/stabilized subbase), and Poisson's Ratio as needed.
17. For frost analysis, select the appropriate Frost Code and edit the Moisture Content and Dry Weight as needed.

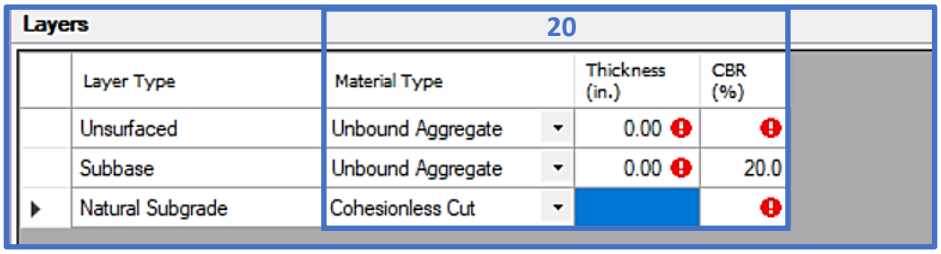
18. After Run Analysis, the FAIR (frost analysis only), Allowable Gross Load, Allowable Passes are displayed for each layer and the Controlling Layer gets flagged.



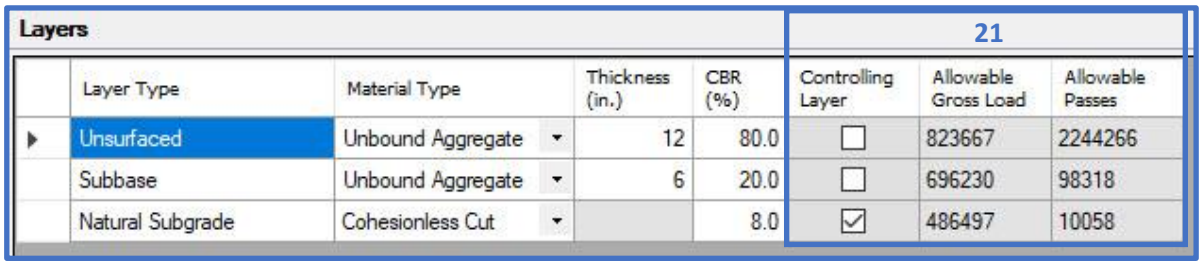
19. Select Show Layer Details to display the Equivalent PCC Thickness and Weighted PCC Flex Strength.



20. For Unsurfaced Pavements select the appropriate Material Type and enter the Thickness and CBR where required.



21. After Run Analysis, the Allowable Gross Load and Allowable Passes are displayed for each layer and the Controlling Layer gets flagged.



22. For Mat Pavements select the appropriate Material Type and enter the Thickness and CBR where required.

Layers — 22

Layer Type	Material Type	Thickness (in.)	CBR (%)
Aluminum Mat	Light Mat		
Subbase	Unbound Aggregate	0.00	
Natural Subgrade	Cohesive Cut		

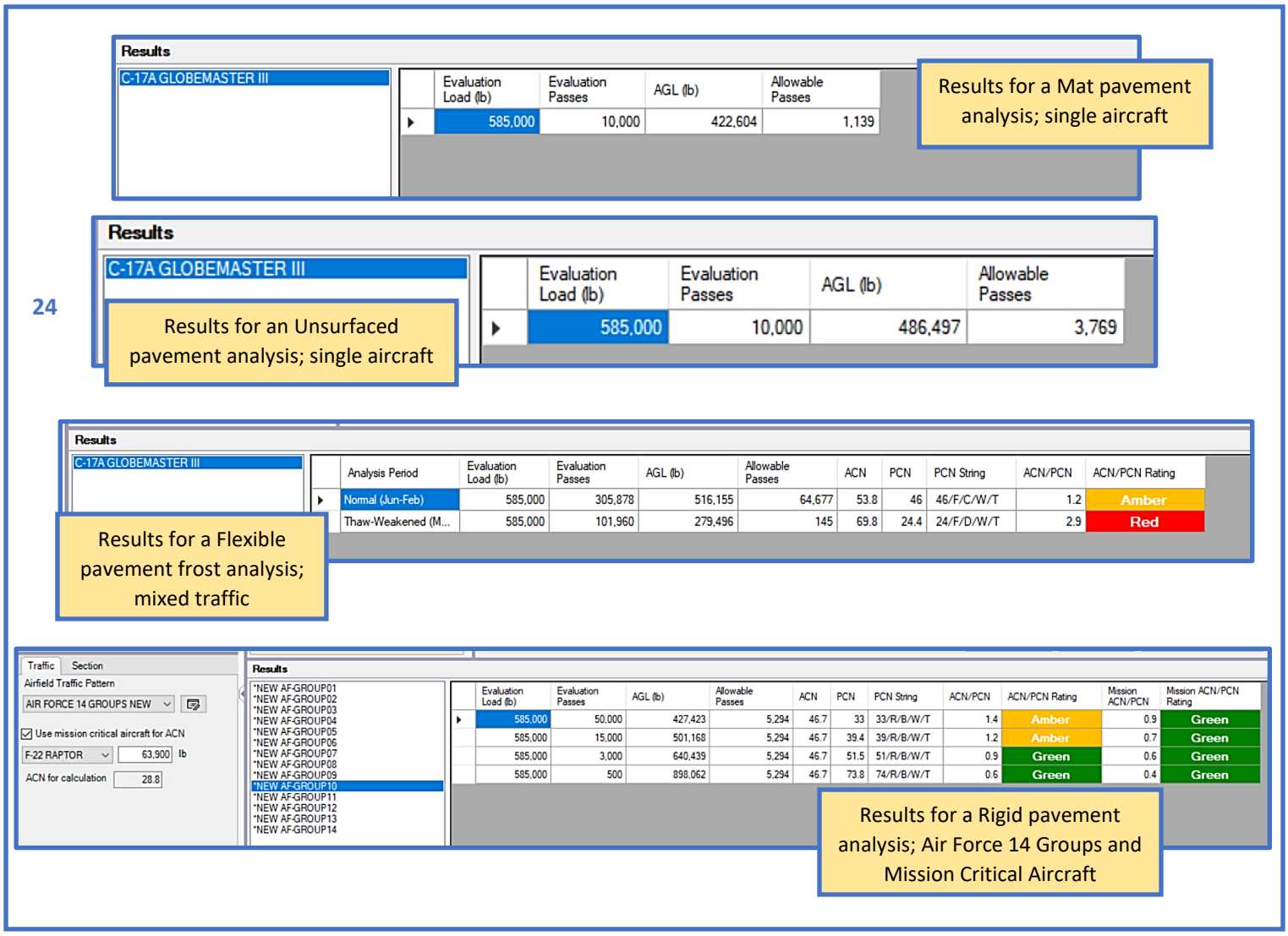
23. After Run Analysis, the Allowable Gross Load and Allowable Passes are displayed for each layer and the Controlling Layer gets flagged.

Layers — 23

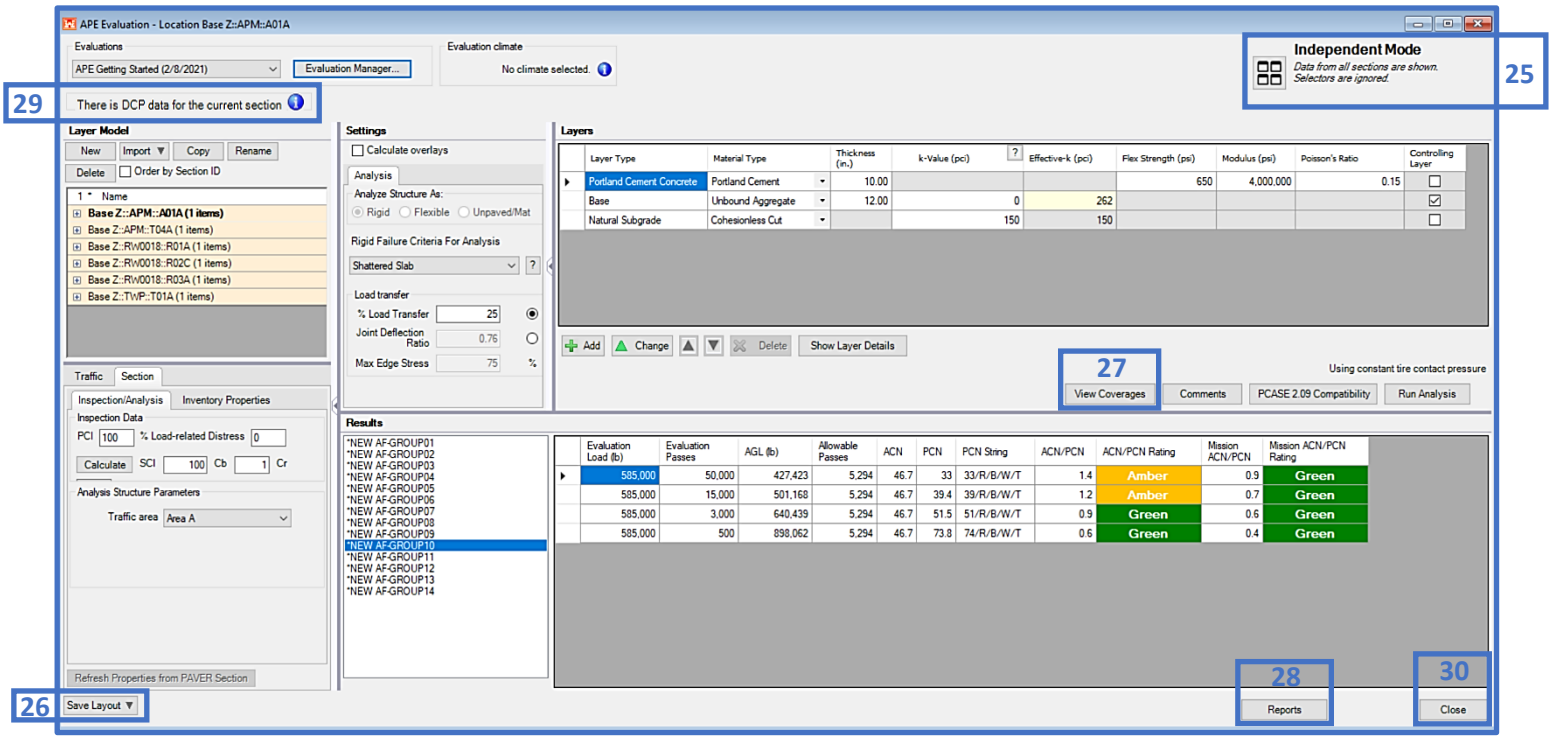
Layer Type	Material Type	Thickness (in.)	CBR (%)	Controlling Layer	Thaw Controlling Layer	Allowable Gross Load (lb)	Allowable Passes
Aluminum Mat	Light Mat			☐	☐		
Subbase	Unbound Aggregate	12.00	20.0	☑	☐	422,604	1,203
Natural Subgrade	Cohesive Cut		8.0	☐	☐	423,899	1,139

14.2.7 Results

24. Once all evaluation parameters are defined, select Run Analysis to execute the evaluation analysis. View the analysis results in the Results grid.



25. Independent mode (default) shows all sections in the Evaluation. To show one section at a time, select the to change to Selector mode; use a selector to change sections individually.
26. Select Save Layout to save panel adjustments made to the form.
27. View Coverages launches a form which displays vehicle pass-to-coverage ratios.
28. Select Reports to access the predefined Evaluation reports. PCASE reports use Excel templates without any classification markings based on the assumption that all data is unclassified and publicly releasable. If the information in the individual database is Controlled Unclassified Information (CUI), properly mark any reports generated by PCASE at the appropriate classification level. Add a header and footer with the appropriate classification markings.
29. If there is DCP data associated with the selected section, a label will populate within the APE form to inform you. Select Import > from DCP to transport the layer model into APE.
30. Select the Close button to exit APE.



14.3 APE Examples

14.3.1 Evaluate pavements by manually inputting layer strength values

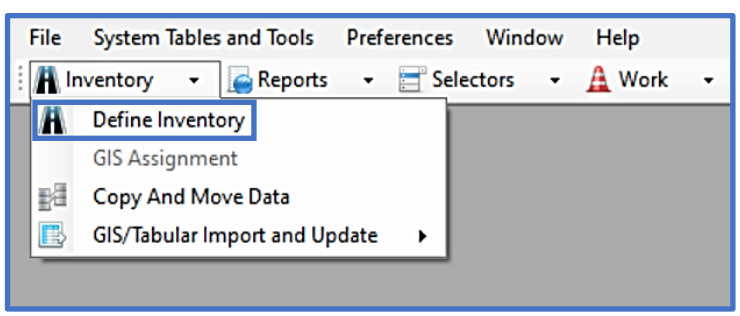
Evaluate the pavements described in Table 1 and 2.

Table 1.					
Grand Forks AFB, ND (Service – Air Force)					
Taxiway A, Section T01A Surface – excellent condition (PCI=100) Traffic - 14-Group Standard Pattern					
Material Properties					
Layer Type / Classification	**Thickness in. (mm)**	**CBR**	**Frost Code**	**% Moisture**	**Dry Unit Weight pcf (kg/m³)**
Asphalt Concrete	5 (127)	--	NFS	0	145 (2,323)
Crushed Stone Base	9 (229)	100	NFS	5	135 (3,429)
Unbound Aggregate Subbase	12 (305)	30	NFS	5	135 (3,429)
Clay loam (cohesive cut)	--	13	F4	20	110 (2,794)

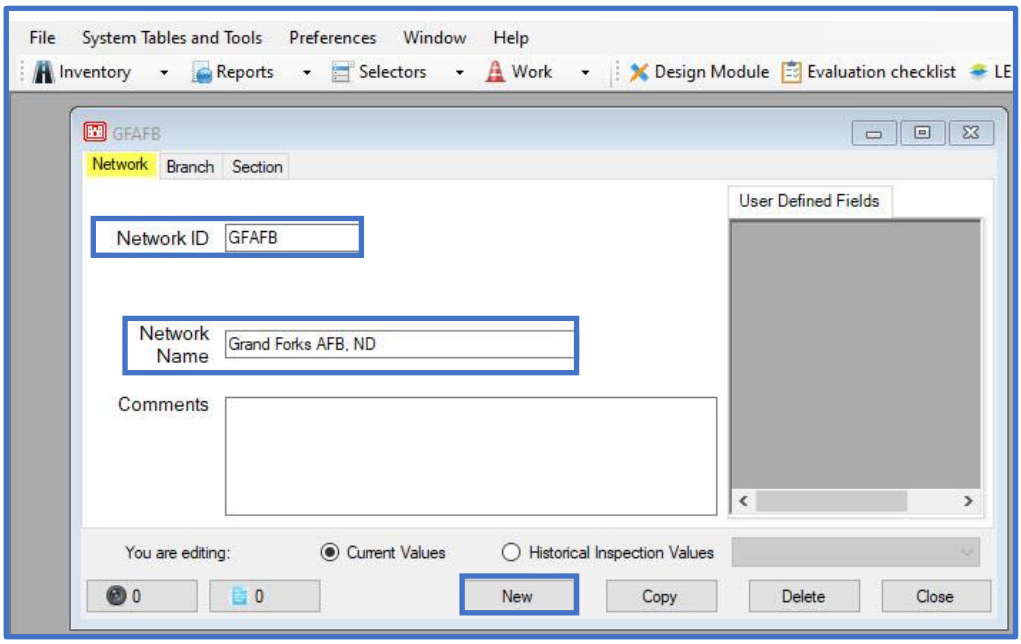
Grand Forks AFB, ND; Taxiway A, Section T01A

Step 1. Define the Inventory

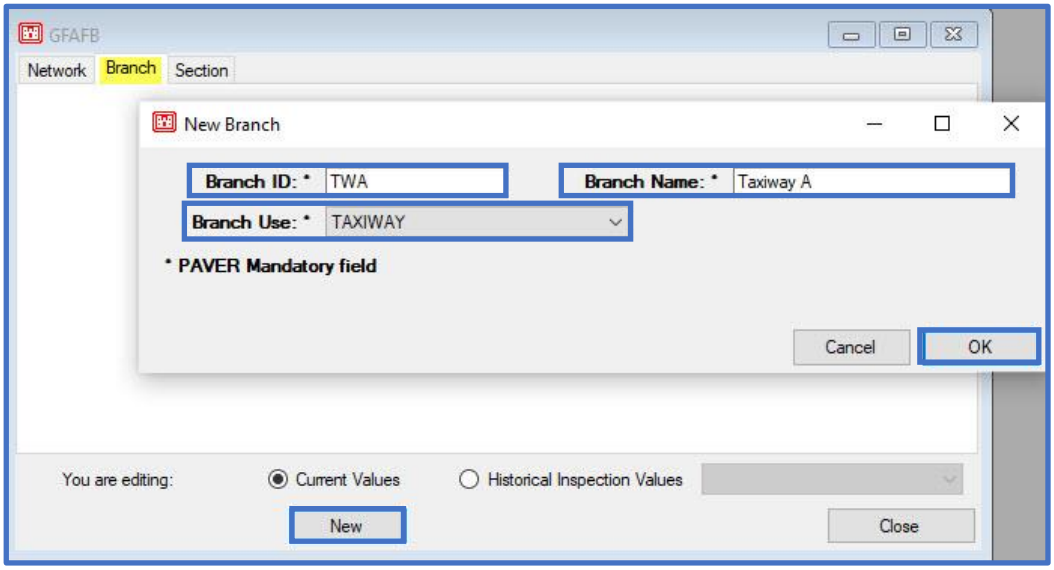
- Use the Inventory pulldown and select Define Inventory



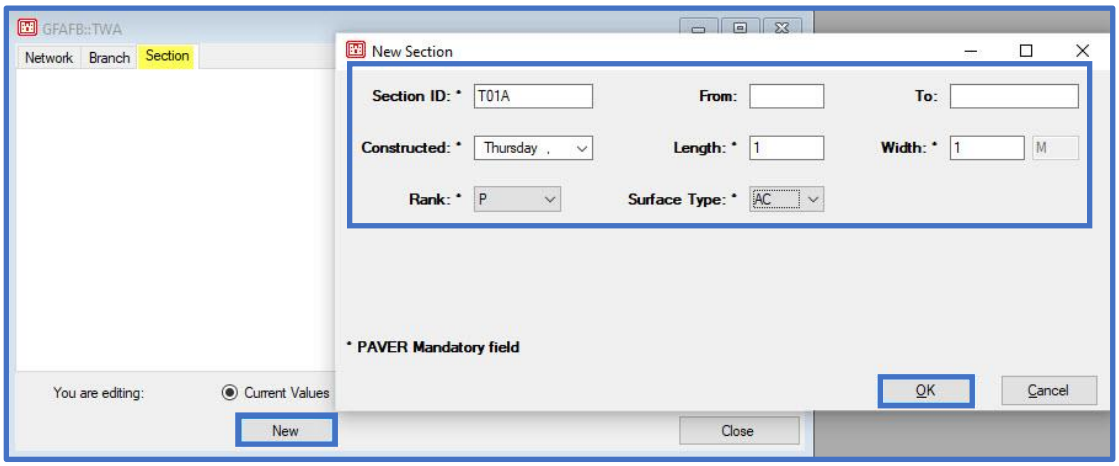
- On the Inventory form, select the Network tab
- Select New
- Type in the Network ID, Network Name, and Comments (optional)



- On the Inventory form, select the Branch tab
- Select New
- Type in the Branch ID, Branch Name, and use the pulldown to select the Branch Use
- Select OK



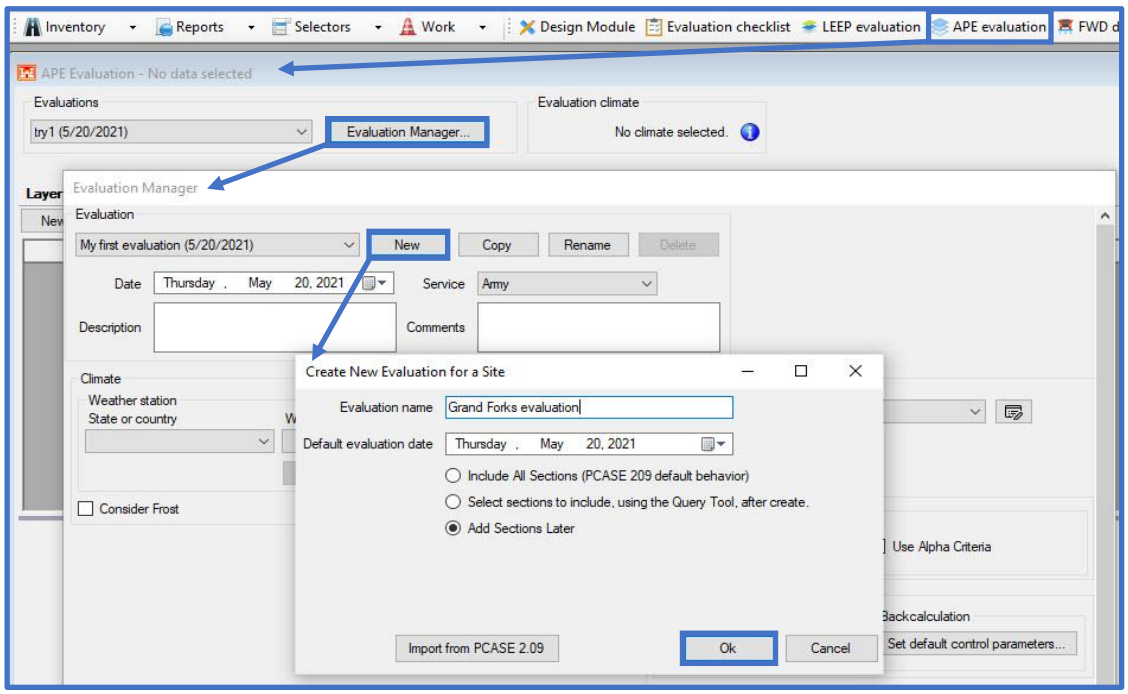
- On the Inventory form, select the Section tab
- Select New
- Type in the Section ID, Length, and Width (required)
- Type in From and To (optional)
- Use the pulldown to select the Constructed date, Rank, and Surface Type (required)
- Select OK



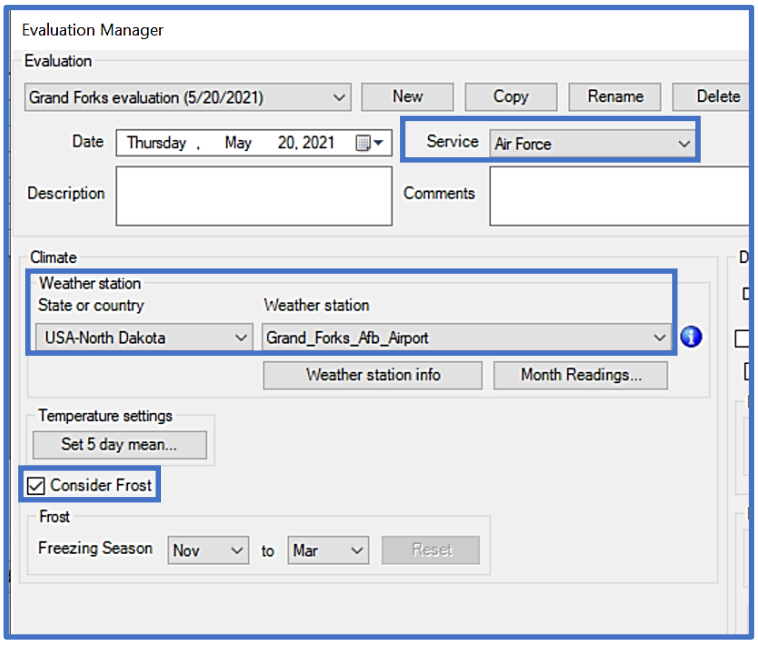
Step 2. Set up the Evaluation

Note: in Table 1, the strength properties are CBR and K values; therefore, use the APE evaluation module to analyze the pavements.

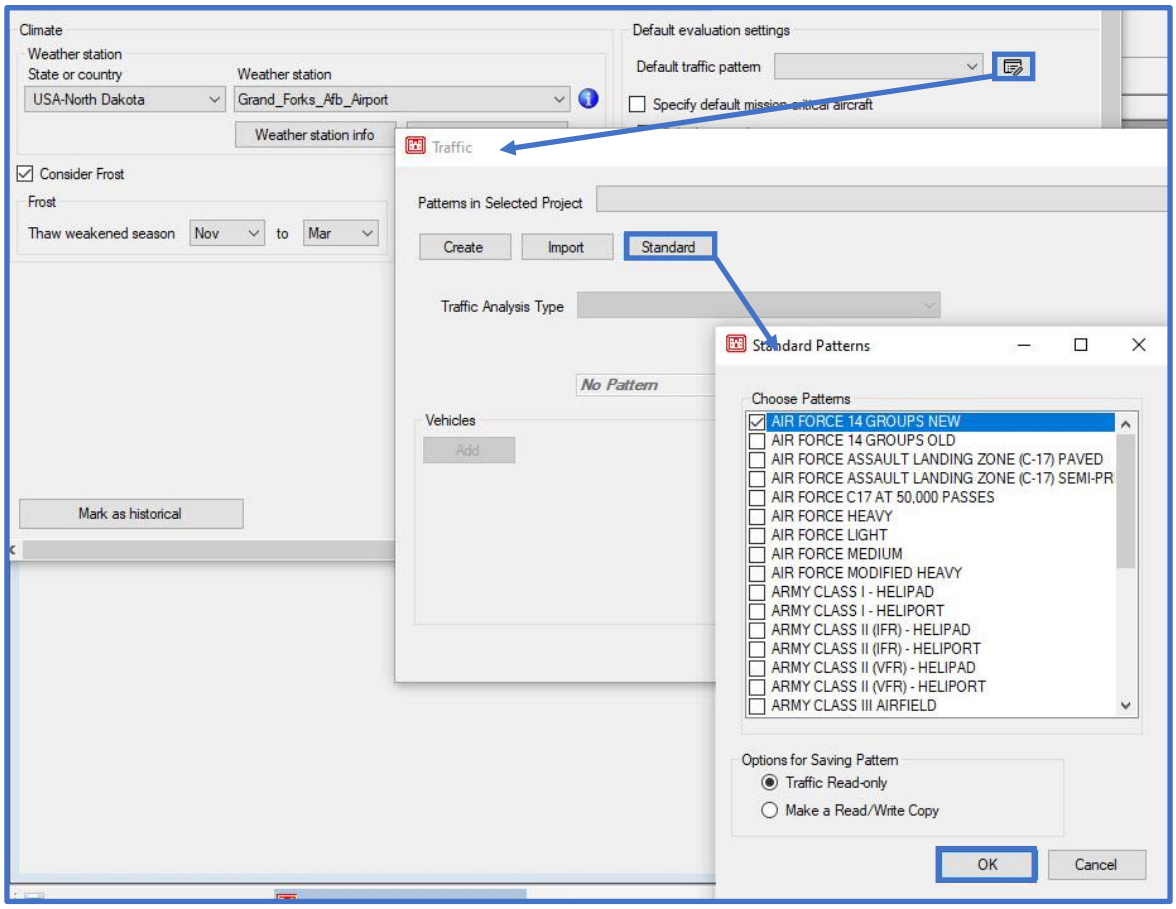
- Select APE evaluation
- On the APE evaluation form; select Evaluation Manager
- On the Evaluation Manager form; select New
- On the Create New Evaluation for the Site form:
  - Type in the Evaluation name
  - Use the pulldown to select the Default evaluation date
  - Select the Add Sections Later radio button
  - Select Ok



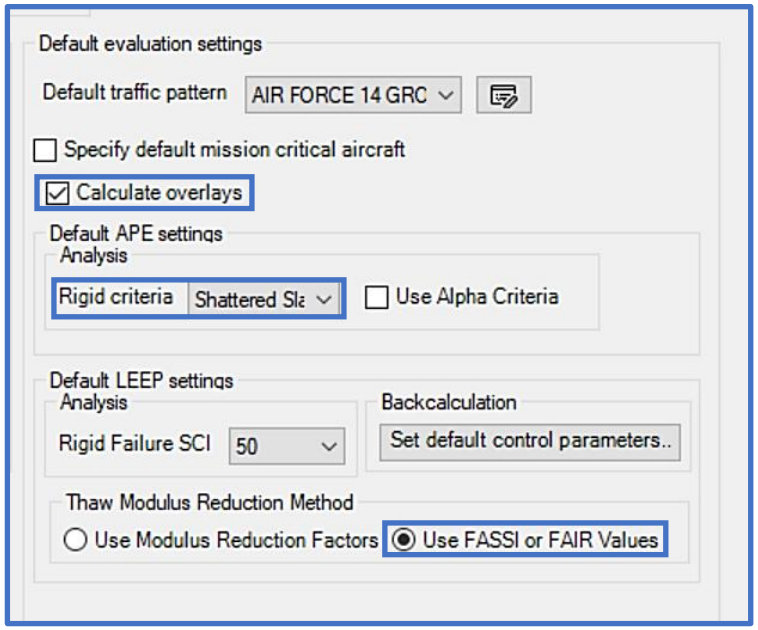
- On the Evaluation Manager form:
  - Use the pulldown for Service and select Air Force
  - Use the pulldown under Climate and select the appropriate Weather Station
  - Check the box for Consider Frost; the Freezing Season will populate based on the Weather Station information in the selected Weather station



- On the Evaluation Manager form, under Default evaluation settings; click on the Default traffic pattern icon
- On the Traffic form; select Standard
- On the Standard Patterns form; select Air Force 14 Groups New
- Select OK

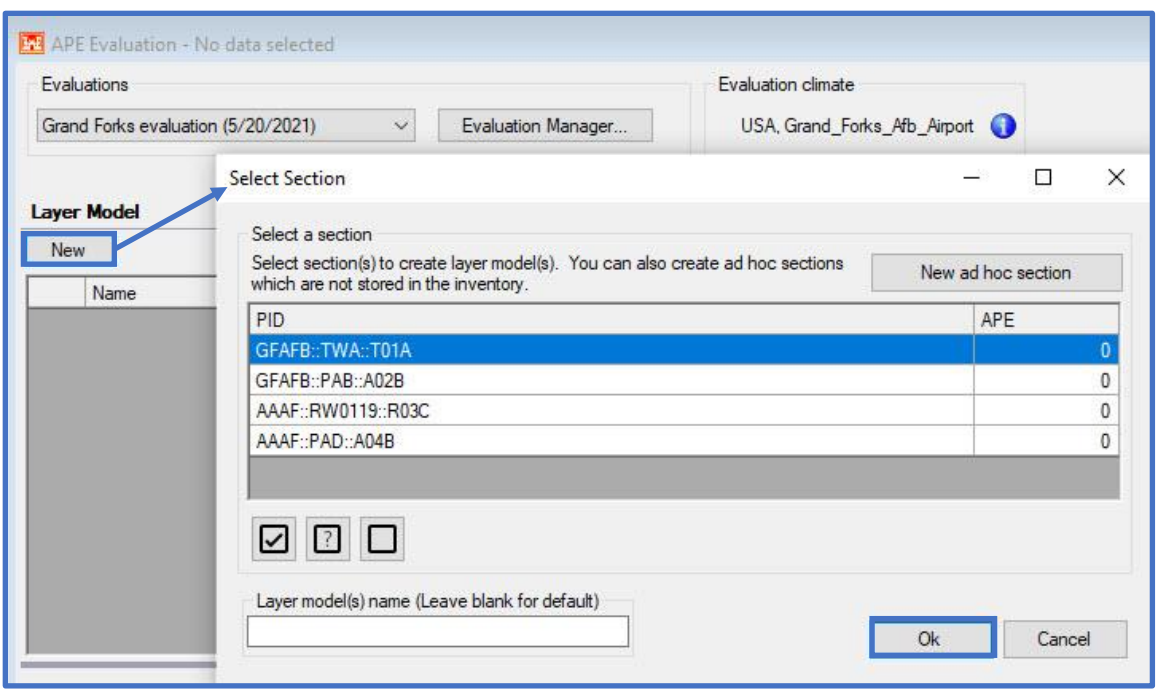


- On the Evaluation Manager form:
  - Under Default evaluation settings; check the box for Calculate overlays
  - Under Default APE settings; ensure the Rigid criteria is set to Shattered Slab
  - LEEP evaluation will not be used for this evaluation; default settings can be left as-is.
  - Under Thaw Modulus Reduction Method select Use FASSI or FAIR Values
  - Select Close to exit the Evaluation Manager and return to APE evaluation

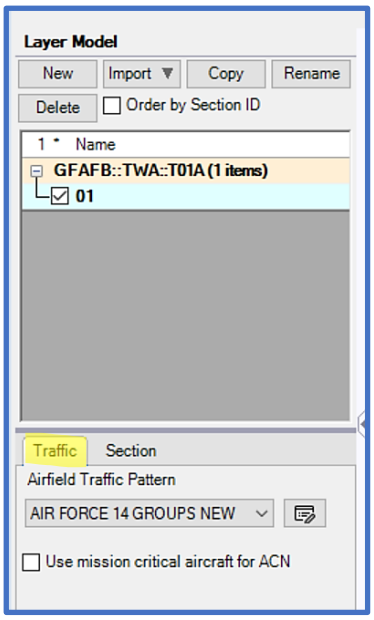


Step 3. Analyze the pavement using APE evaluation

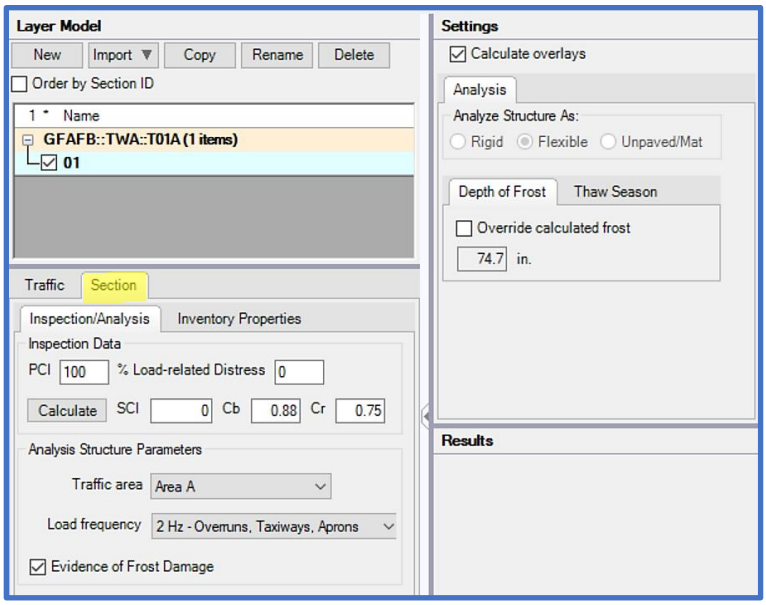
- On the APE Evaluation form; select New
- On the Select Section form; select the appropriate PID
- Select Ok



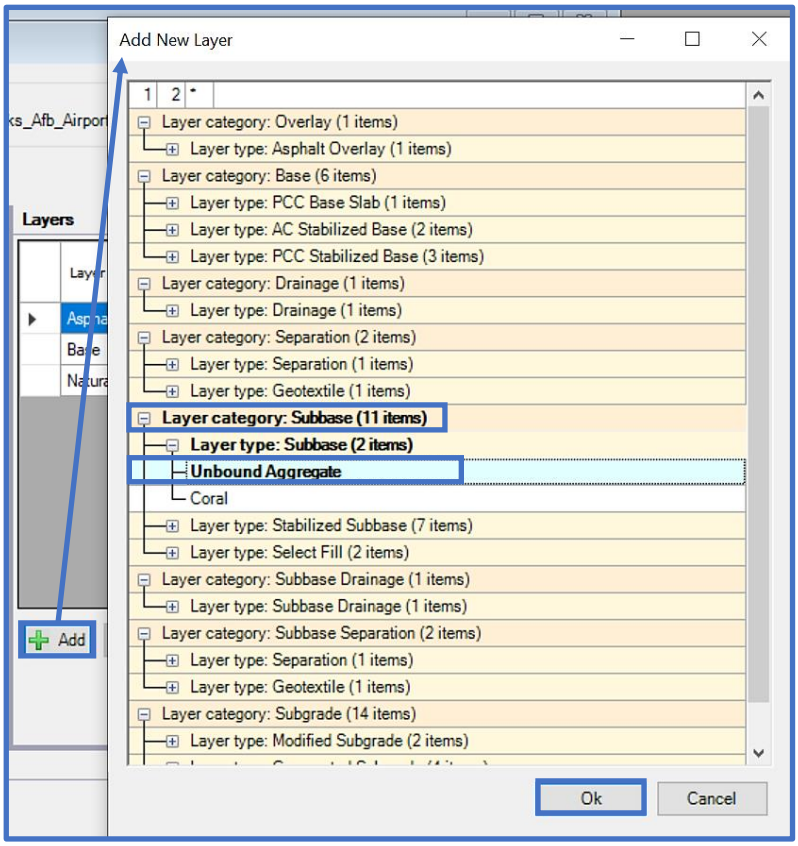
- On the APE evaluation form, under Layer Model, the selected PID populates
- Select the Traffic tab to ensure that the appropriate traffic pattern is selected, if not select the Air Force 14 Groups pattern from the drop-list



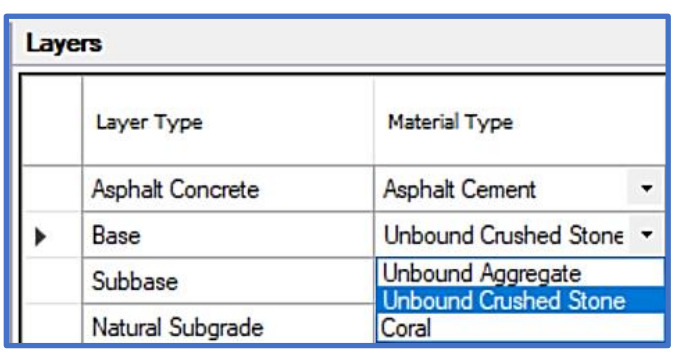
- Select the Section tab; all properties shown are correct, no need to edit section properties
- Under Settings it defaults to Calculate overlays as indicated in Evaluation Manager
- Under the Analysis tab
  - Flexible is selected, as indicated in Define Inventory
  - The Depth of Frost displays based on the selected Weather Station



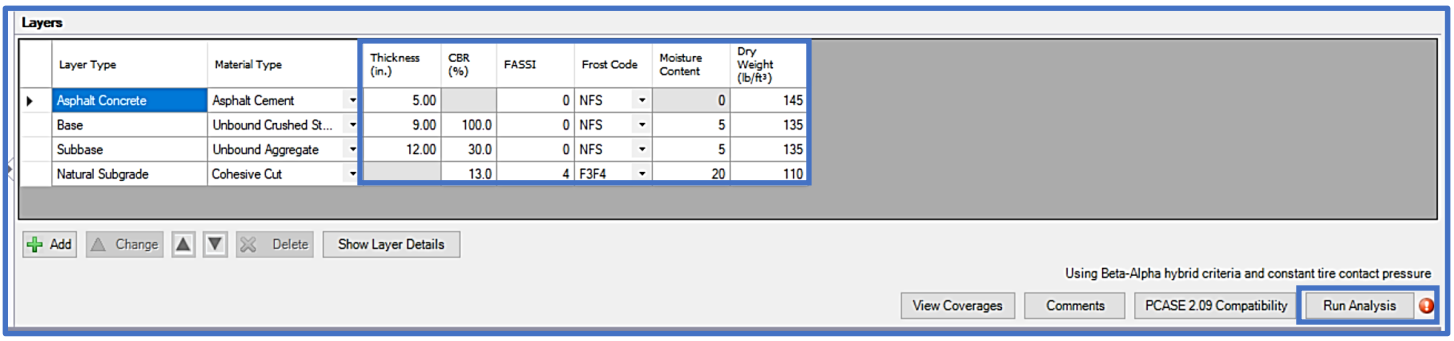
- On the APE evaluation form, in the Layers grid a default pavement section displays; select Add, + Subbase, Unbound Aggregate
- Select Ok



- Change the Base layer's Material Type to Unbound Crushed Stone and the Natural Subgrade Material Type to Cohesive Cut

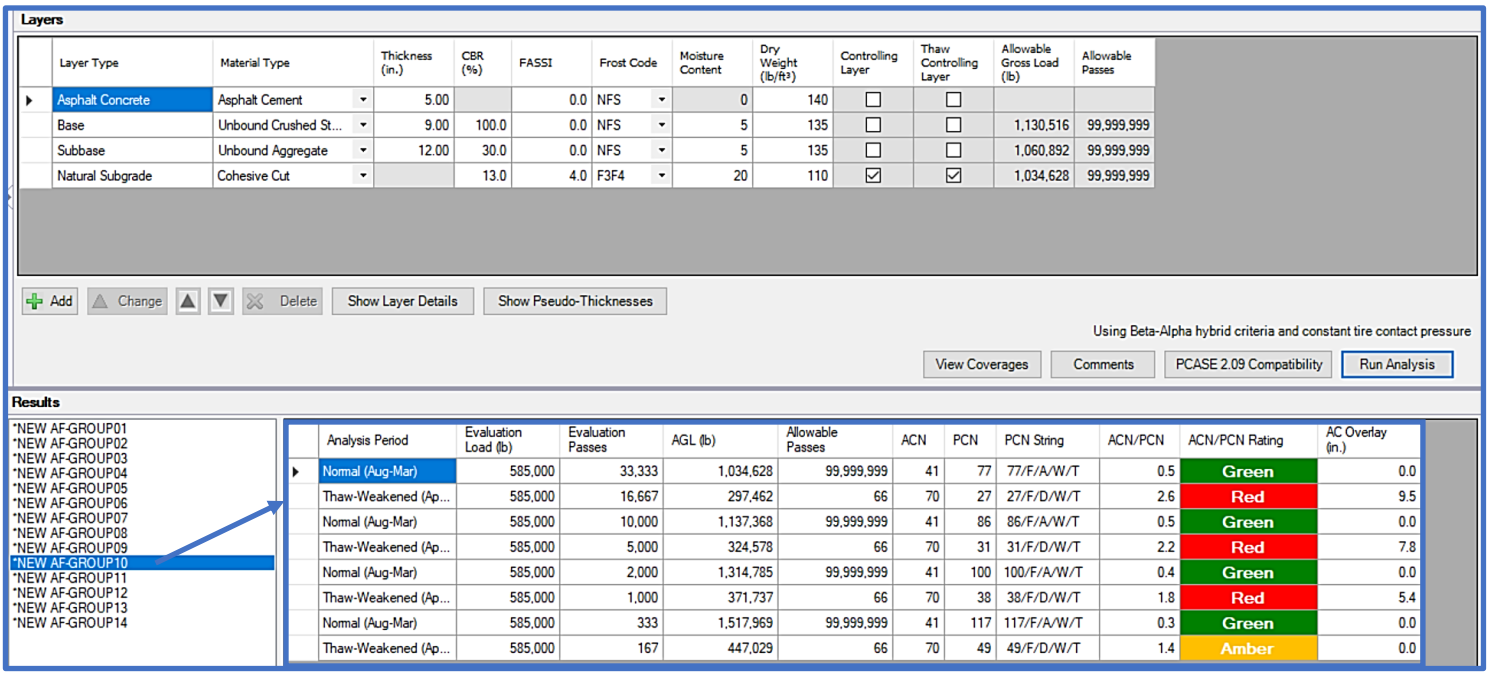


- Input the Thickness, CBR, Frost Code, Moisture Content, and Dry Unit Weight values for each layer (see Table 1 or reference image below).
- Select Run Analysis



Layer Type	Material Type	Thickness (in.)	CBR (%)	FASSI	Frost Code	Moisture Content	Dry Weight (lb/ft³)
Asphalt Concrete	Asphalt Cement	5.00		0	NFS	0	145
Base	Unbound Crushed St...	9.00	100.0	0	NFS	5	135
Subbase	Unbound Aggregate	12.00	30.0	0	NFS	5	135
Natural Subgrade	Cohesive Cut		13.0	4	F3F4	20	110

- Under Results; select New AF Group 10



Layer Type	Material Type	Thickness (in.)	CBR (%)	FASSI	Frost Code	Moisture Content	Dry Weight (lb/ft³)	Controlling Layer	Thaw Controlling Layer	Allowable Gross Load (lb)	Allowable Passes
Asphalt Concrete	Asphalt Cement	5.00		0.0	NFS	0	140	☐	☐		
Base	Unbound Crushed St...	9.00	100.0	0.0	NFS	5	135	☐	☐	1,130,516	99,999,999
Subbase	Unbound Aggregate	12.00	30.0	0.0	NFS	5	135	☐	☐	1,060,892	99,999,999
Natural Subgrade	Cohesive Cut		13.0	4.0	F3F4	20	110	☑	☑	1,034,628	99,999,999

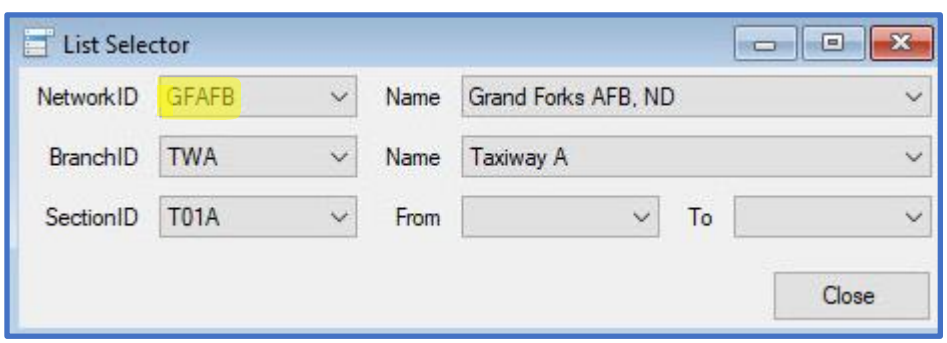
Analysis Period	Evaluation Load (lb)	Evaluation Passes	AGL (lb)	Allowable Passes	ACN	PCN	PCN String	ACN/PCN	ACN/PCN Rating	AC Overlay (in.)
Normal (Aug-Mar)	585,000	33,333	1,034,628	99,999,999	41	77	77/F/A/W/T	0.5	Green	0.0
Thaw-Weakened (Ap...	585,000	16,667	297,462	66	70	27	27/F/D/W/T	2.6	Red	9.5
Normal (Aug-Mar)	585,000	10,000	1,137,368	99,999,999	41	86	86/F/A/W/T	0.5	Green	0.0
Thaw-Weakened (Ap...	585,000	5,000	324,578	66	70	31	31/F/D/W/T	2.2	Red	7.8
Normal (Aug-Mar)	585,000	2,000	1,314,785	99,999,999	41	100	100/F/A/W/T	0.4	Green	0.0
Thaw-Weakened (Ap...	585,000	1,000	371,737	66	70	38	38/F/D/W/T	1.8	Red	5.4
Normal (Aug-Mar)	585,000	333	1,517,969	99,999,999	41	117	117/F/A/W/T	0.3	Green	0.0
Thaw-Weakened (Ap...	585,000	167	447,029	66	70	49	49/F/D/W/T	1.4	Amber	0.0

Table 2.					
Grand Forks AFB, ND (Service – Air Force)					
Apron B, Section A02B Surface – poor condition (PCI=40; load distress=75%) Traffic – 14-Group Standard Pattern					
Layer Type / Classification	**Thickness in. (mm)**	**K Pci (kPa/mm)**	**Frost Code**	**% Moisture**	**Dry Unit Weight pcf (kg/m³)**
Portland Cement Concrete Flex strength = 650 psi (4.48 MPa)	20 (508)	--	NFS	0	145 (2,323)
Sandy Gravel (GW) Base	4 (102)	--	NFS	5	135 (3,429)
Clay loam (cohesive cut)	--	125	F4	20	110 (2,794)

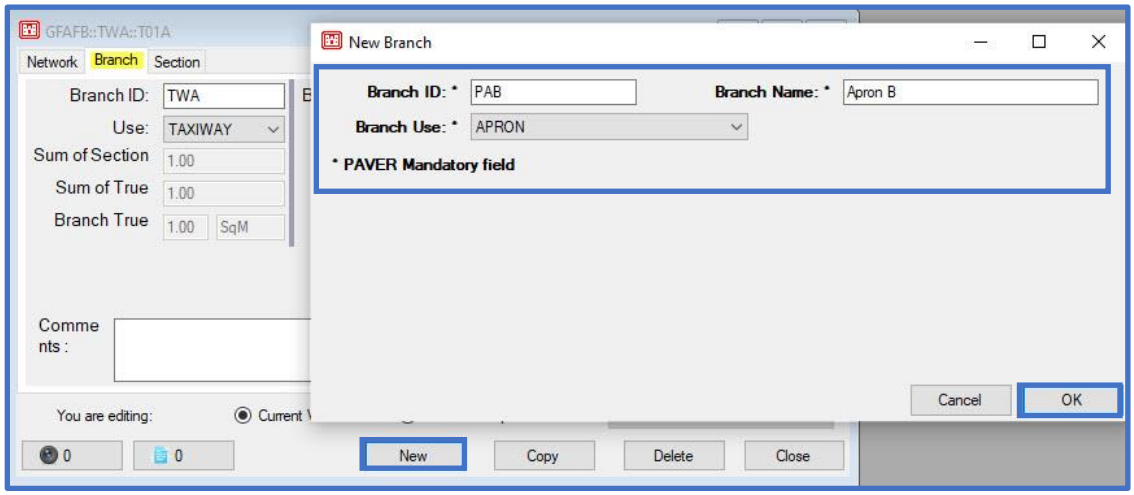
Grand Forks AFB, Apron B, Section A02B

Step 1. Define the Inventory

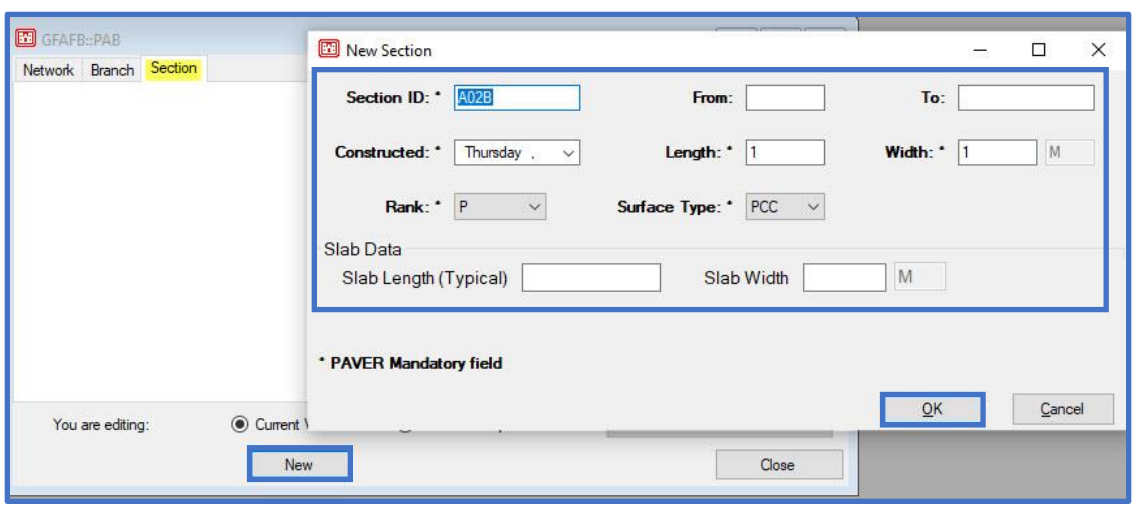
- Use the Inventory pulldown and select Define Inventory
- On the Inventory form, select the Network tab
- If the Network ID is not GFAFB; use the List Selector to select the appropriate Network ID.



- On the Inventory form, in the GFAFB Network, select the Branch tab
- Select New
- Type in the Branch ID, Branch Name, and use the pulldown to select the Branch Use
- Select OK



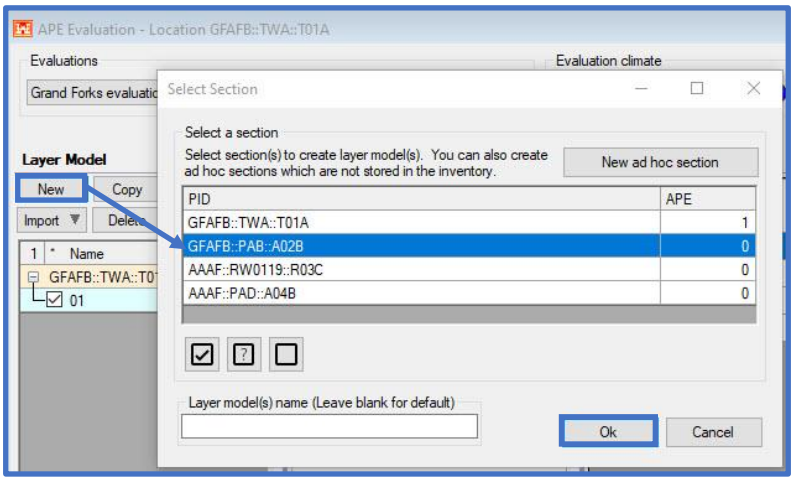
- On the Inventory form, select the Section tab
- Select New
- Type in the Section ID, Length, and Width (required)
- Type in From, To, and Slab Data (optional)
- Use the pulldown to select the Constructed date, Rank, and Surface Type (required)
- Select OK



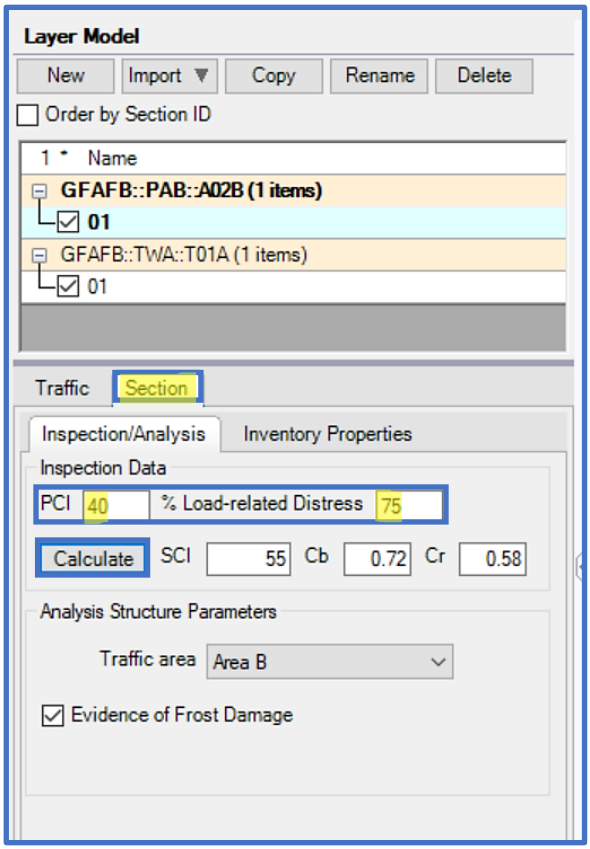
Evaluation Manager (Step 2) was accomplished in the previous example (Taxiway A, Section T01A); proceed to Step 3.

Step 3. Analyze the pavement using APE evaluation

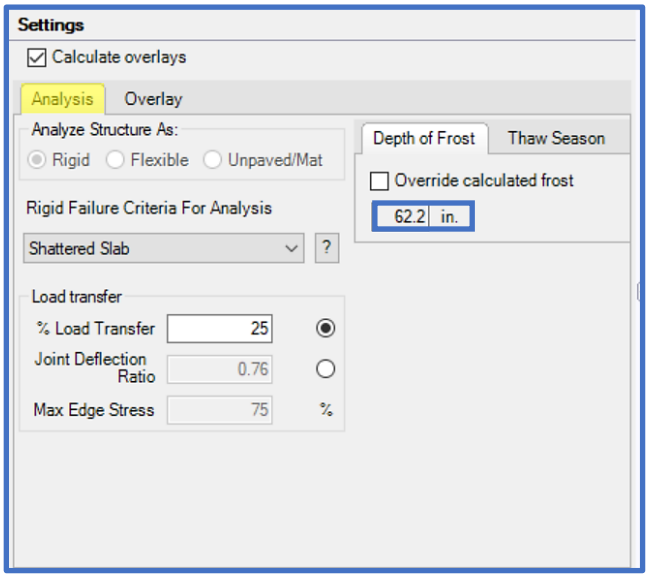
- On the APE evaluation form; select New
- On the Select Section form; select the appropriate PID
- Select Ok



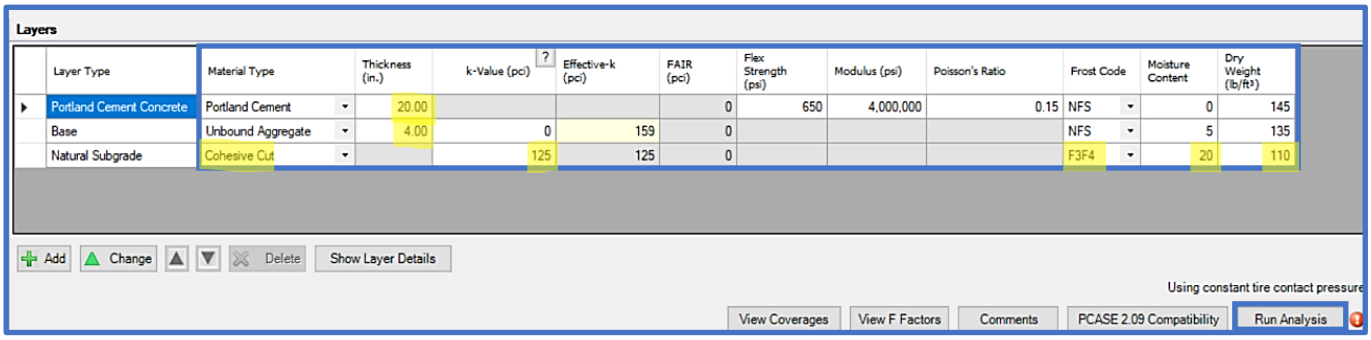
- On the APE evaluation form, under Layer Model; the selected PID populates
- Select the Traffic tab; use the Airfield Traffic Pattern pulldown to select and use the Traffic Pattern Air Force 14 Groups New
- Select the Section tab
  - Input the appropriate PCI and % Load-related Distress (see Table 2)
  - Select Calculate to display the resultant SCI, C_b, and C_r
  - All other properties shown are correct, no need for further edits



- Under Settings, Calculate overlays is turned on by default as indicated in Evaluation Manager
- Under the Analysis tab
  - Rigid is selected for structure analysis, as indicated in Define Inventory
  - The Depth of Frost displays
  - Click on the Thaw Season tab to view or override the calculated thaw season

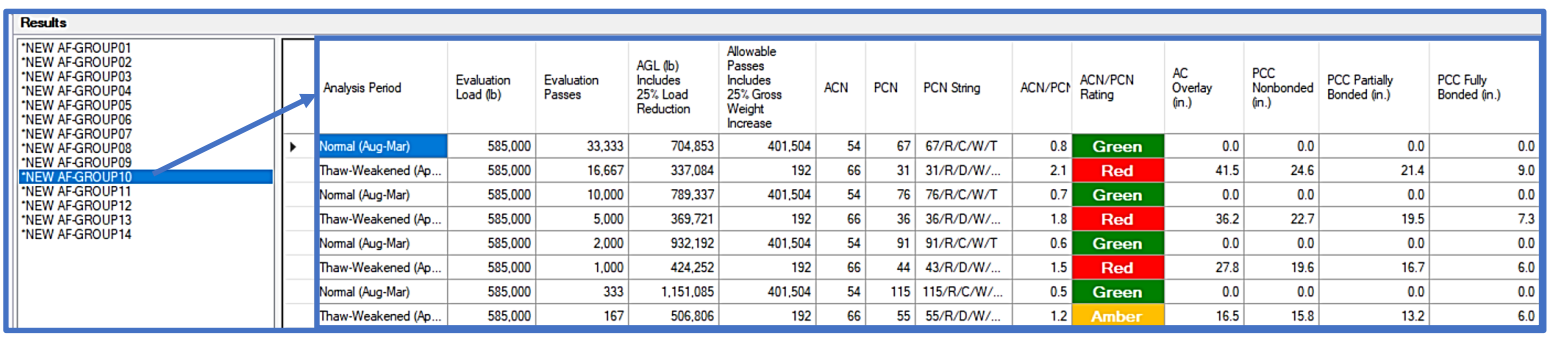


- On the APE evaluation form, in the Layers grid, a default pavement section displays
- Input the Thickness, K, Flexural Strength, Frost Code Moisture Content, and Dry Unit Weight values for each layer (as shown below or in Table 2)
- Keep the default values for Modulus and Poisson's Ratio
- Select Run Analysis



Layer Type	Material Type	Thickness (in.)	k-Value (pci)	Effective-k (pci)	FAIR (pci)	Flex Strength (psi)	Modulus (psi)	Poisson's Ratio	Frost Code	Moisture Content	Dry Weight (lb/ft³)
Portland Cement Concrete	Portland Cement	20.00			0	650	4,000,000	0.15	NFS	0	145
Base	Unbound Aggregate	4.00	0	159	0				NFS	5	135
Natural Subgrade	Cohesive Cut		125	125	0				F3F4	20	110

- Under Results; select New AF Group 10



Analysis Period	Evaluation Load (lb)	Evaluation Passes	AGL (lb) Includes 25% Load Reduction	Allowable Passes Includes 25% Gross Weight Increase	ACN	PCN	PCN String	ACN/PCN	ACN/PCN Rating	AC Overlay (in.)	PCC Nonbonded (in.)	PCC Partially Bonded (in.)	PCC Fully Bonded (in.)
Normal (Aug-Mar)	585,000	33,333	704,853	401,504	54	67	67/R/C/W/T	0.8	Green	0.0	0.0	0.0	0.0
Thaw-Weakened (Ap...	585,000	16,667	337,084	192	66	31	31/R/D/W/...	2.1	Red	41.5	24.6	21.4	9.0
Normal (Aug-Mar)	585,000	10,000	789,337	401,504	54	76	76/R/C/W/T	0.7	Green	0.0	0.0	0.0	0.0
Thaw-Weakened (Ap...	585,000	5,000	369,721	192	66	36	36/R/D/W/...	1.8	Red	36.2	22.7	19.5	7.3
Normal (Aug-Mar)	585,000	2,000	932,192	401,504	54	91	91/R/C/W/T	0.6	Green	0.0	0.0	0.0	0.0
Thaw-Weakened (Ap...	585,000	1,000	424,252	192	66	44	43/R/D/W/...	1.5	Red	27.8	19.6	16.7	6.0
Normal (Aug-Mar)	585,000	333	1,151,085	401,504	54	115	115/R/C/W/...	0.5	Green	0.0	0.0	0.0	0.0
Thaw-Weakened (Ap...	585,000	167	506,806	192	66	55	55/R/D/W/...	1.2	Amber	16.5	15.8	13.2	6.0

14.3.2 Evaluate pavements using DCP results

Evaluate the pavement Section A03B, Branch HP1, at Stallion AAF, using the DCP results from example 16.3.1 Importing a DCP File and Performing Analysis and parameters provided in Table 3.

Table 3.		
Stallion AAF, White Sands, NM (Service – Army)		
HP1, Section A03B Surface pavement – Flexible Pavement structure from DCP results; reference Example 16.3.1 Frost is not a consideration Calculate overlays		
Traffic		
Aircraft	**Load – A, B [lb (kg)]**	**Passes – A, B, C**
C-130H	130,000 (58,967)	14,400
UH-60	16,600 (7,530)	4,800

Step 1. Open the database containing the DCP data and analysis

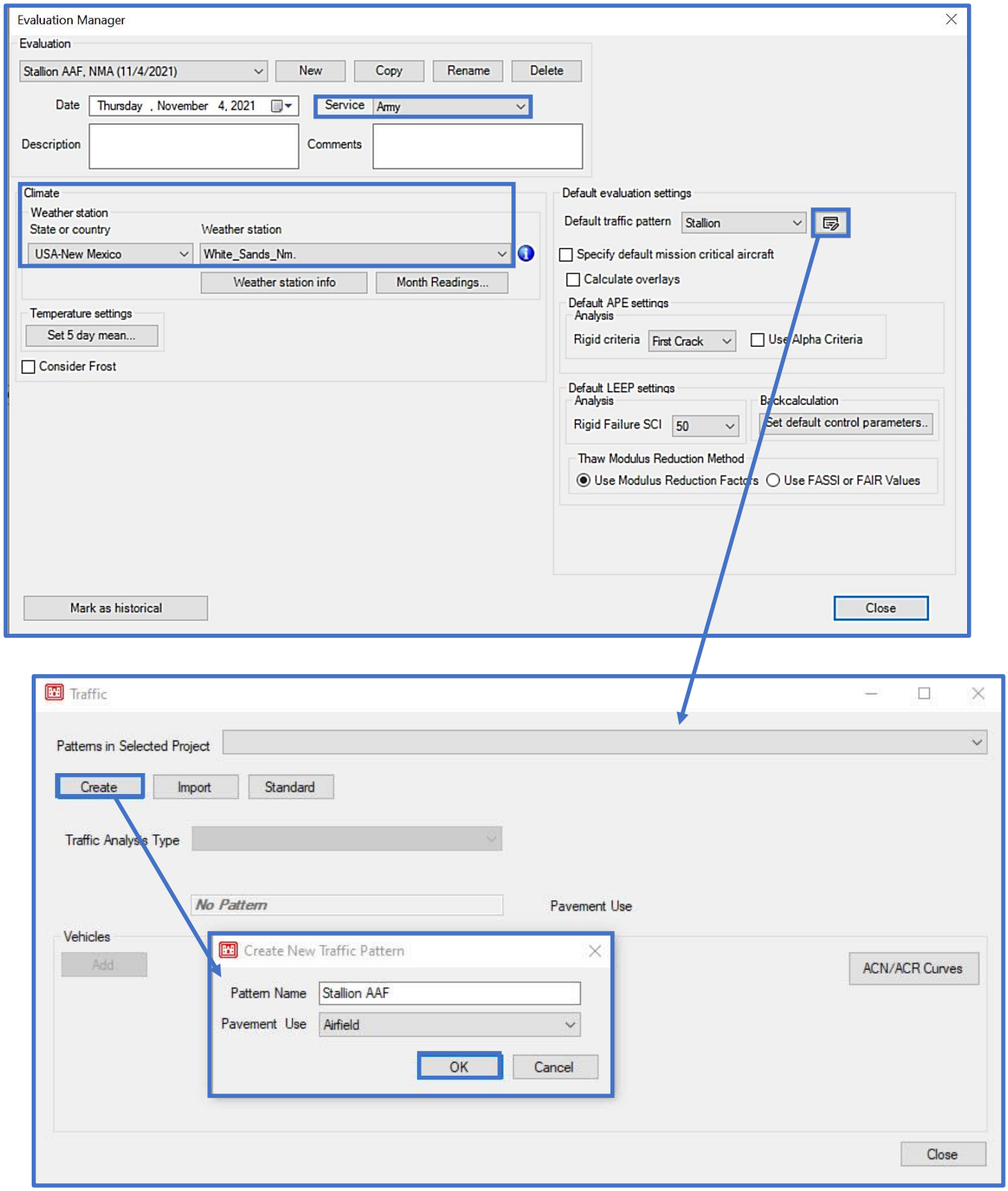
Step 2. Open APE evaluation

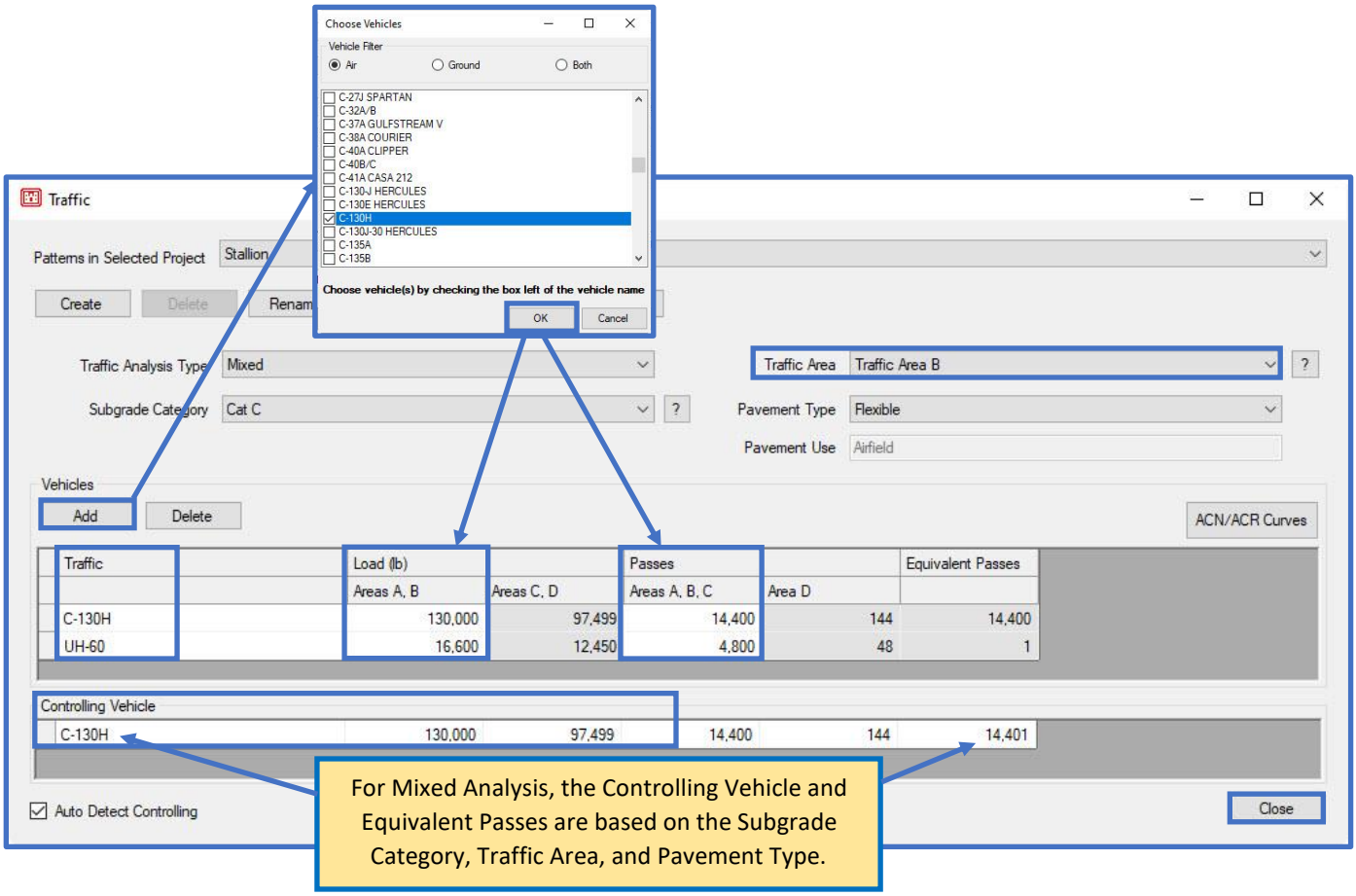
Step 3. Define traffic and settings

- Select Evaluation Manager
  - Use the drop-list for Service and select Army
  - Use the drop-list under Climate and select the appropriate Weather Station *(optional since Frost is not a consideration and FWD data is not being used in this example)*
  - On the Evaluation Manager form, under Default evaluation settings; click on the Default traffic pattern icon 
    - On the Traffic form; select Create
      - Enter a Pattern name
      - Use the drop-list to select the Pavement use
      - Select Ok
    - Under Vehicles select Add
      - Select the appropriate vehicles; then OK upon completion
      - Enter the Load and Passes indicated in Table 3

Note: On the Traffic form, for a mixed analysis; select the subgrade category (from the DCP analysis), traffic area, and pavement type to display the controlling vehicle and equivalent passes. This is optional, since this process may be also performed in the APE form/analysis.

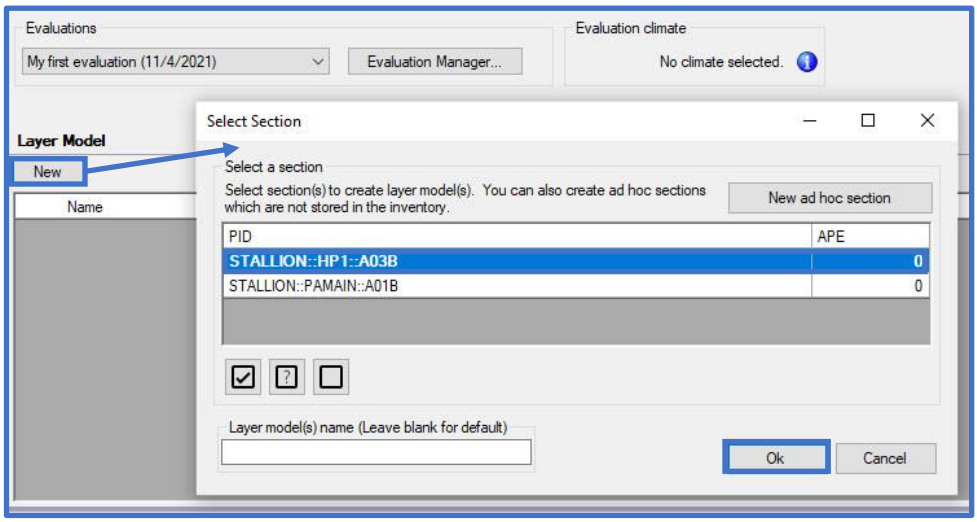
- To exit the Traffic form; select Close
- To exit the Evaluation Manager; select Close


Evaluation Manager
Evaluation
Stallion AAF, NMA (11/4/2021)
New
Copy
Rename
Delete
Date
Thursday , November 4, 2021
Service
Army
Description
Comments
Climate
Weather station
State or country
Weather station
USA-New Mexico
White_Sands_Nm.
Weather station info
Month Readings...
Temperature settings
Set 5 day mean...
Consider Frost
Default evaluation settings
Default traffic pattern
Stallion
Specify default mission critical aircraft
Calculate overlays
Default APE settings
Analysis
Rigid criteria
First Crack
Use Alpha Criteria
Default LEEP settings
Analysis
Rigid Failure SCI
50
Backcalculation
Set default control parameters..
Thaw Modulus Reduction Method
Use Modulus Reduction Factors
Use FASSI or FAIR Values
Mark as historical
Close
Traffic
Patterns in Selected Project
Create
Import
Standard
Traffic Analysis Type
No Pattern
Pavement Use
Vehicles
Add
Create New Traffic Pattern
Pattern Name
Stallion AAF
Pavement Use
Airfield
OK
Cancel
ACN/ACR Curves
Close

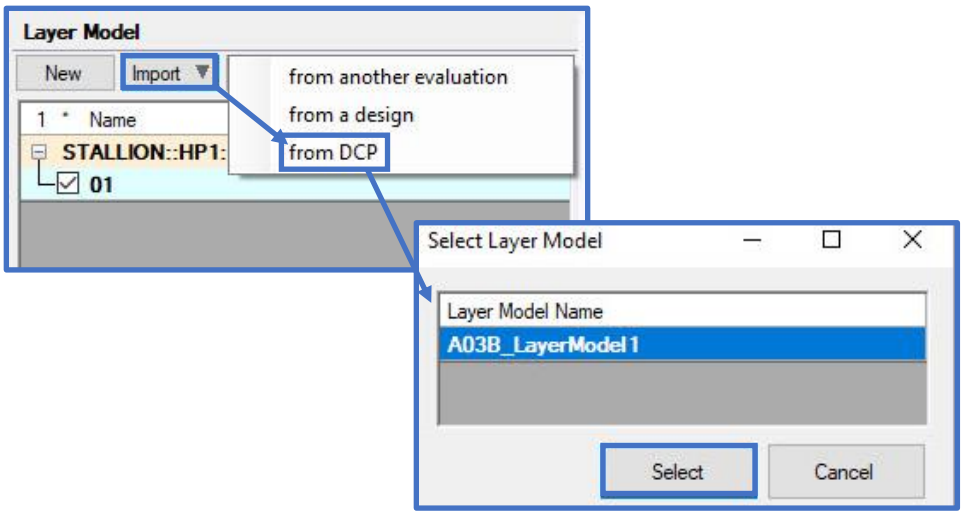


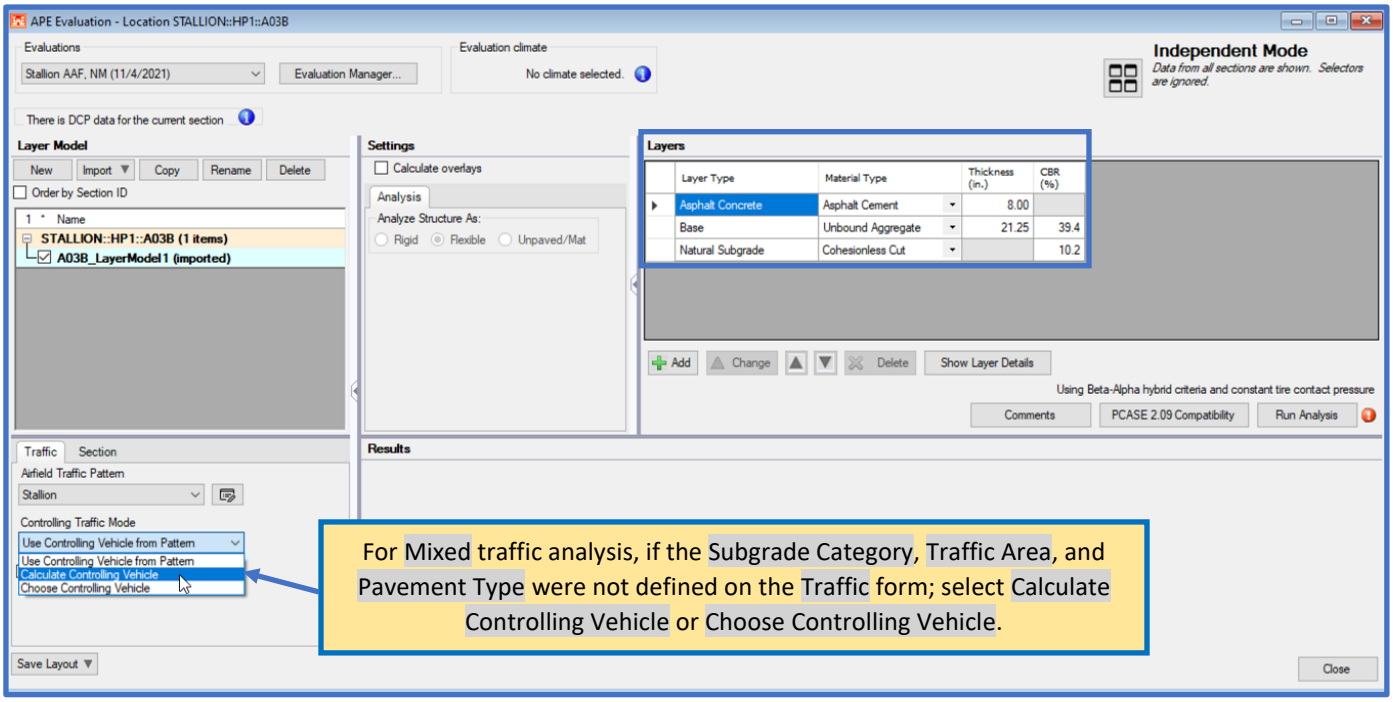
Step 4. Import DCP data

- On the APE evaluation form, under Layer Model; select New
  - On the Select Section form; select STALLION::HP1::A03B
  - Select Ok to exit the form



- On the APE evaluation form, under Layer Model
  - Use the Import pulldown to select from DCP
- On the Select Layer Model form
  - Select A03B_LayerModel1
  - Click on Select to exit the form
- The DCP layer model is imported and displayed in the Layers grid



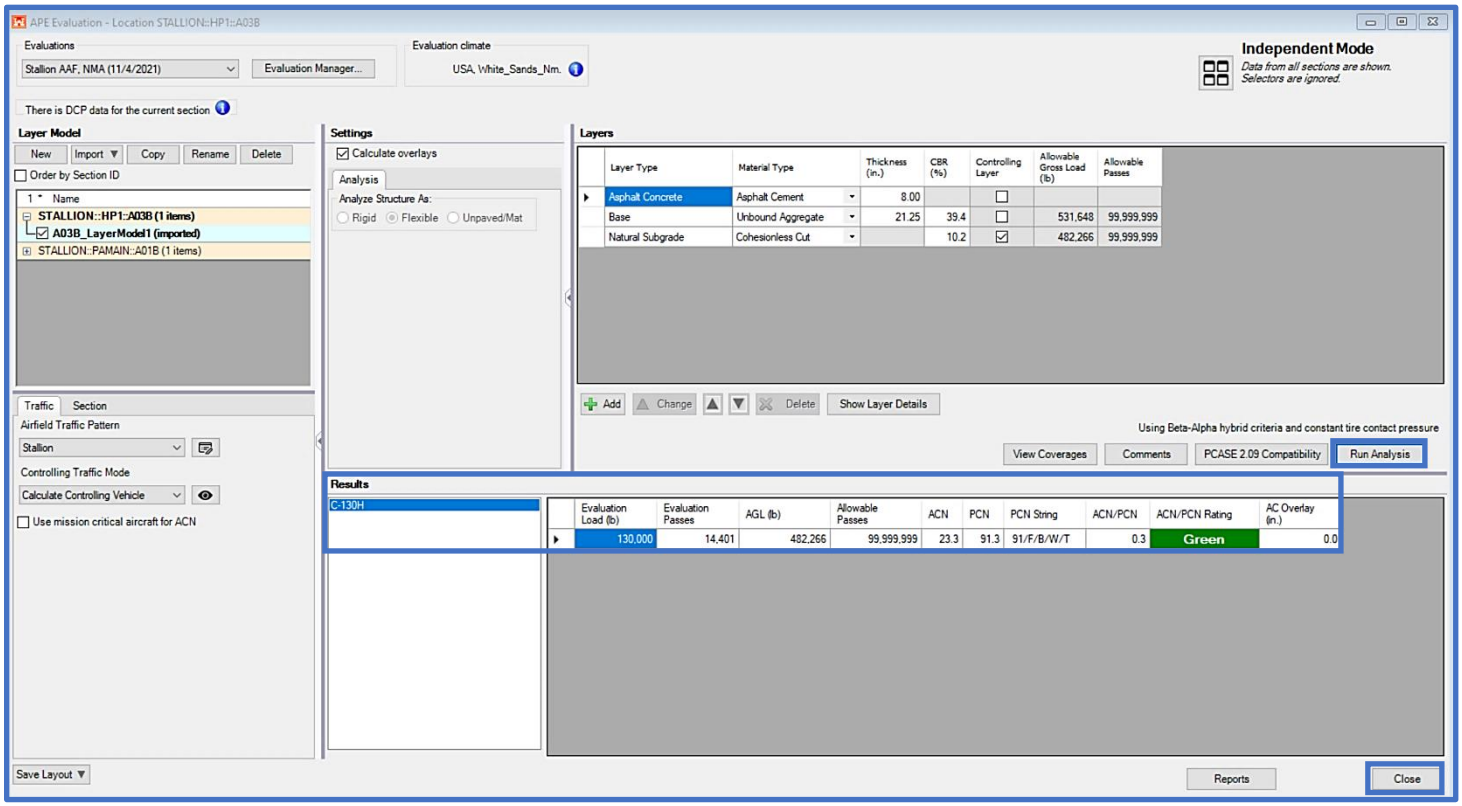


For Mixed traffic analysis, if the Subgrade Category, Traffic Area, and Pavement Type were not defined on the Traffic form; select Calculate Controlling Vehicle or Choose Controlling Vehicle.

Step 5. Run Analysis

- To complete the analysis; select Run Analysis
- Results are displayed in the Results grid

To exit APE evaluation; select Close.



15 FWD data

FWD data provides a dashboard to upload, view, and analyze FWD/HWD data. This interface provides data visualization tools of deflection basin information and parameters which allow you to perform quality control of structural data, and to select basins for backcalculation and subsequent analyses in LEEP evaluation.

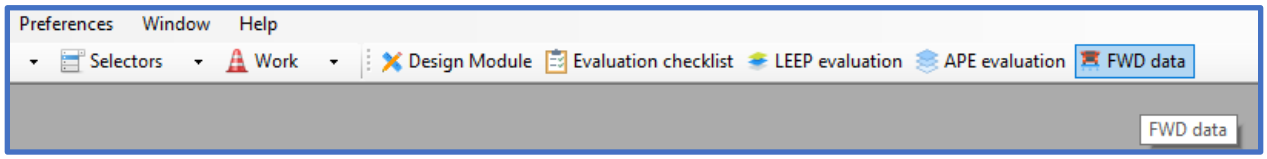
Prior to beginning a new evaluation, ensure that you have opened or created a database to store the evaluation within (database name is displayed on the bottom-left of the main window). For instructions on how to import or create a database; reference Chapter 2 File Menu.

Prior to using the FWD data form, ensure you have defined an inventory (unless you will be creating sections Ad Hoc); reference Chapter 7 Inventory.

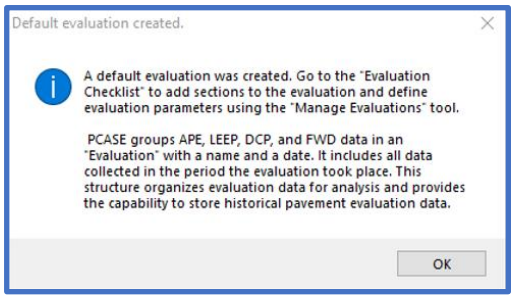
The asset inventory should be initialized prior to using the FWD data form; reference Chapter 12 Evaluation checklist.

15.1 Getting Started

Select FWD data on the PCASE 7 tool bar to open the FWD data tool.



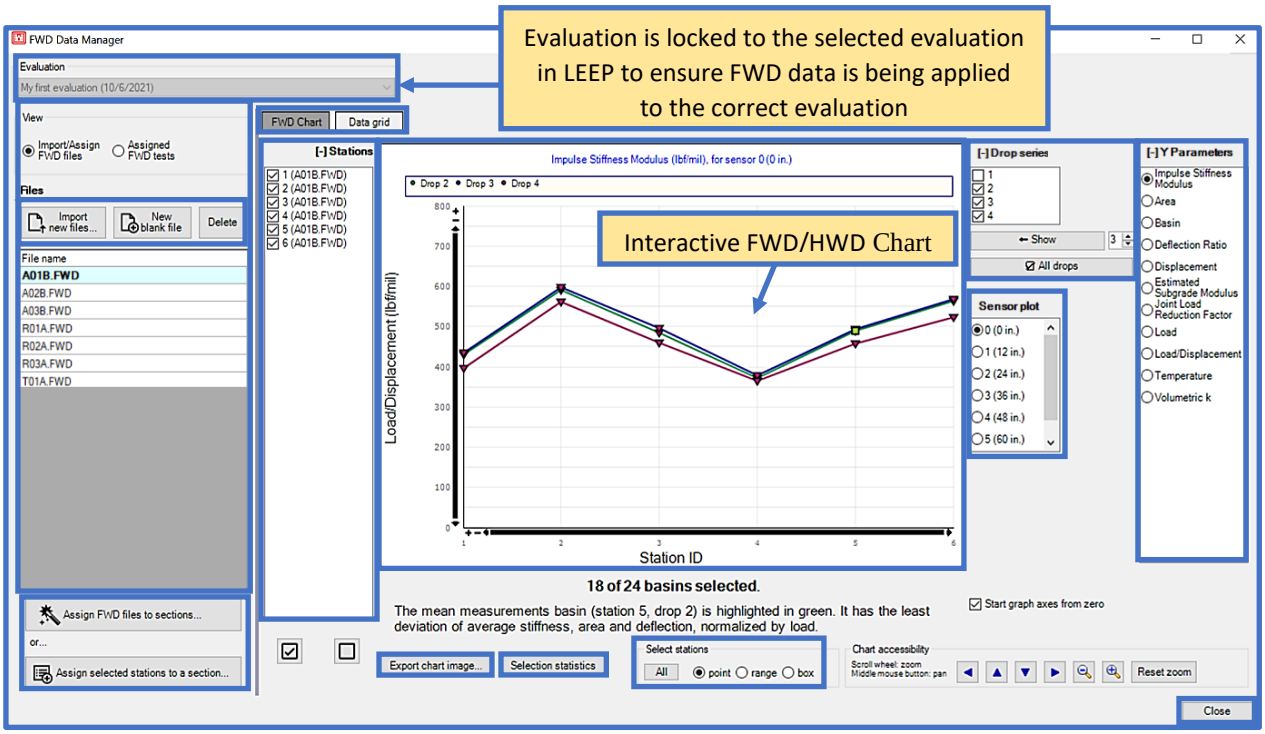
If you have not imported or created an evaluation in the current database, the message below pops up indicating a default evaluation was created. Click OK to continue and open the FWD data form.



15.2 FWD data form

The FWD data manager serves as the interface to import/enter deflection basin data, pre-process, and assign FWD/HWD deflection data to inventory sections. Additionally, data visualization features are integrated into the form for viewing the deflection basin parameters (e.g., ISM, etc.), associated section trends, and descriptive statistics. This form is also accessible from within the LEEP evaluation form. The assigned FWD/HWD data assigned to inventory sections are then utilized as part of subsequent pavement analysis within the LEEP evaluation form. To learn how to perform a LEEP analysis, reference Chapter 13 LEEP evaluation.

The FWD data form is displayed below. As part of data processing and performing QC/QA of deflection data, you will perform different operations through the selection of applicable functions provided under the different sub-sections within the form. The primary functions consist of: Import/Assign FWD files, Assign FWD tests, Assign selected stations to a section, FWD Chart, Data grid, Select stations, Drop series selection, Sensor plot, Y-axis Parameters (i.e., Deflection Basin Parameters), Selection statistics, and Export chart image. Select Close to exit the form.



15.2.1 Evaluation Manager

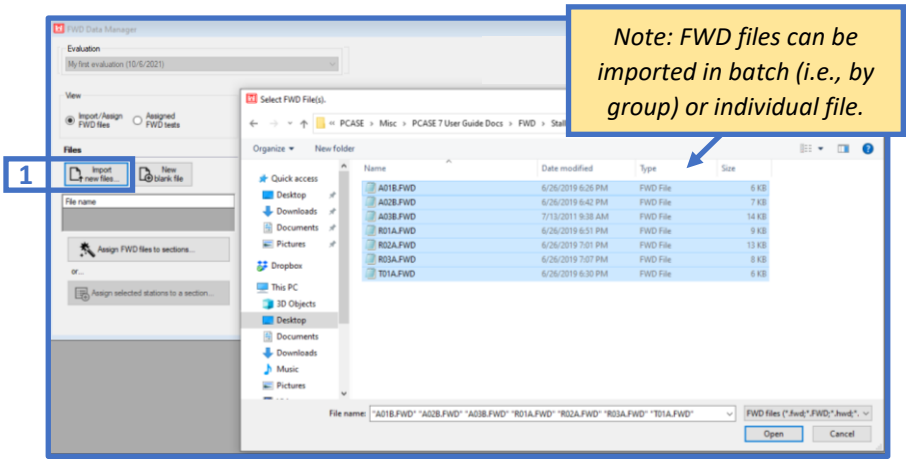
Evaluation Manager serves to establish global analysis parameters. To navigate Evaluation Manager; reference Chapter 12 Evaluation Checklist, Section 12.3 Evaluation Manager.

15.2.2 Import, Enter and Assign FWD/HWD Files to Section Inventory

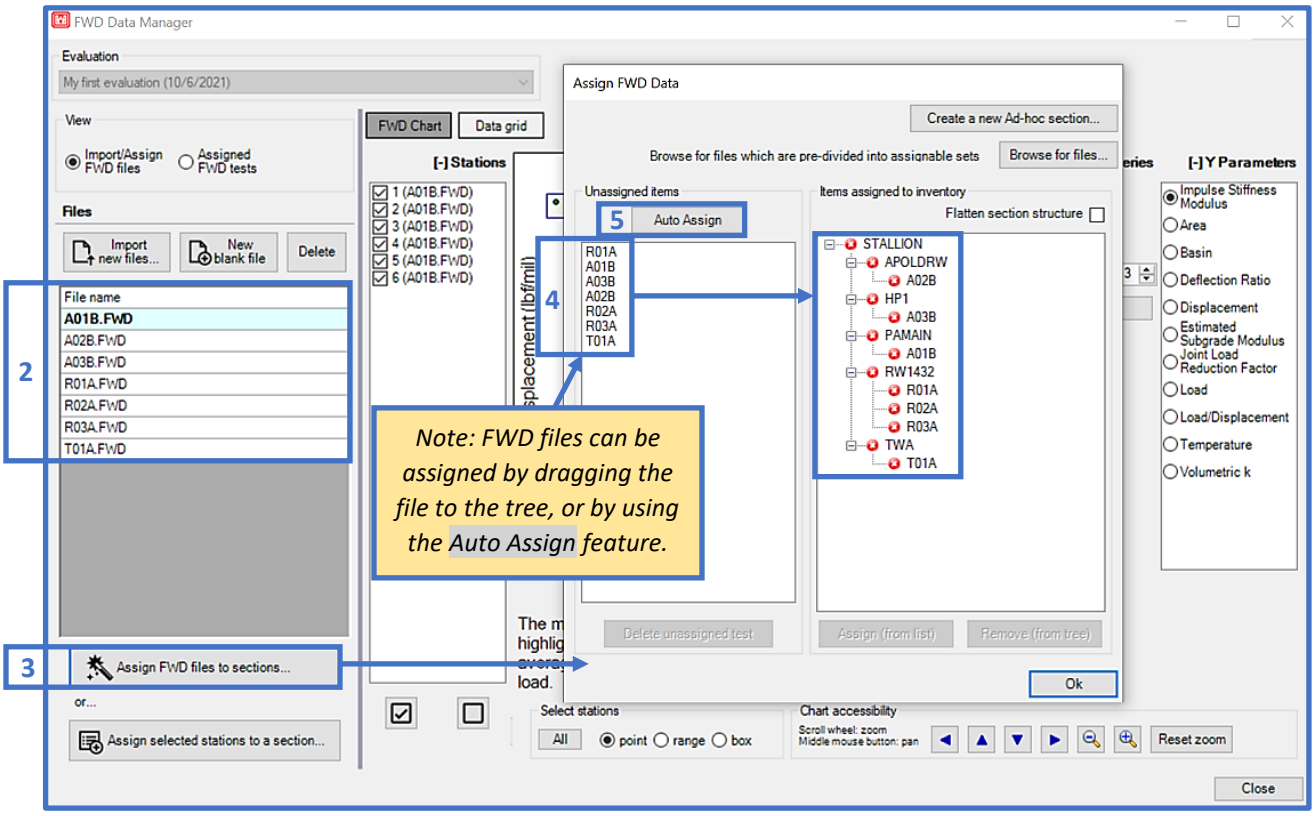
The FWD data form provides different modes for uploading deflection basin data. Deflection basin data can be uploaded through .FWD or .HWD files. Parameters in these data files can also be edited or modified using the FWD Data grid. FWD and HWD data can also be entered manually in the FWD data form itself. Once deflection basin data is uploaded or entered, then you can employ functions within the FWD data form to assign the data to inventory sections. The following demonstrates modes on how to upload and assign FWD and HWD data:

- To import FWD/HWD raw data files in their raw data format, select Import new files…. If PCASE 7 does not currently support your .FWD or .HWD data file, then contact: USACE-TSC, George.W.VanSteenburg@usace.army.mil for further technical support.
- To manually enter deflection data and associated parameters, select New blank file.
- View imported FWD/HWD or manually entered deflection information in graphical format through the FWD Chart feature, or in tabular format through the Data grid feature.

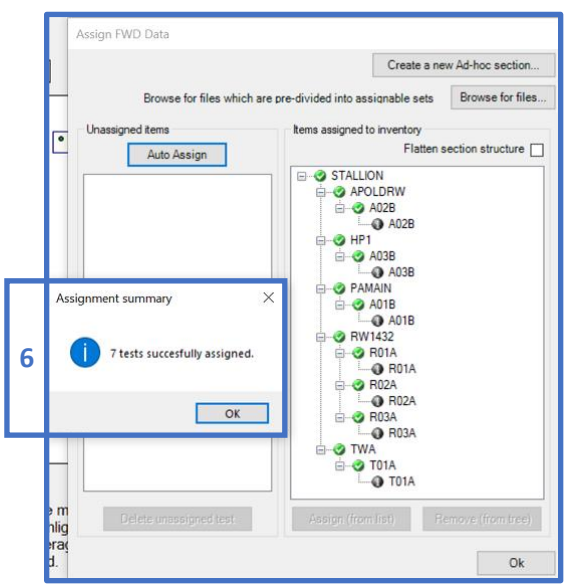
1. Select Import new files… to choose the FWD/HWD files to import. The FWD/HWD files can be imported in a batch (by selecting multiple files) or individually. Select Open to initialize the import.



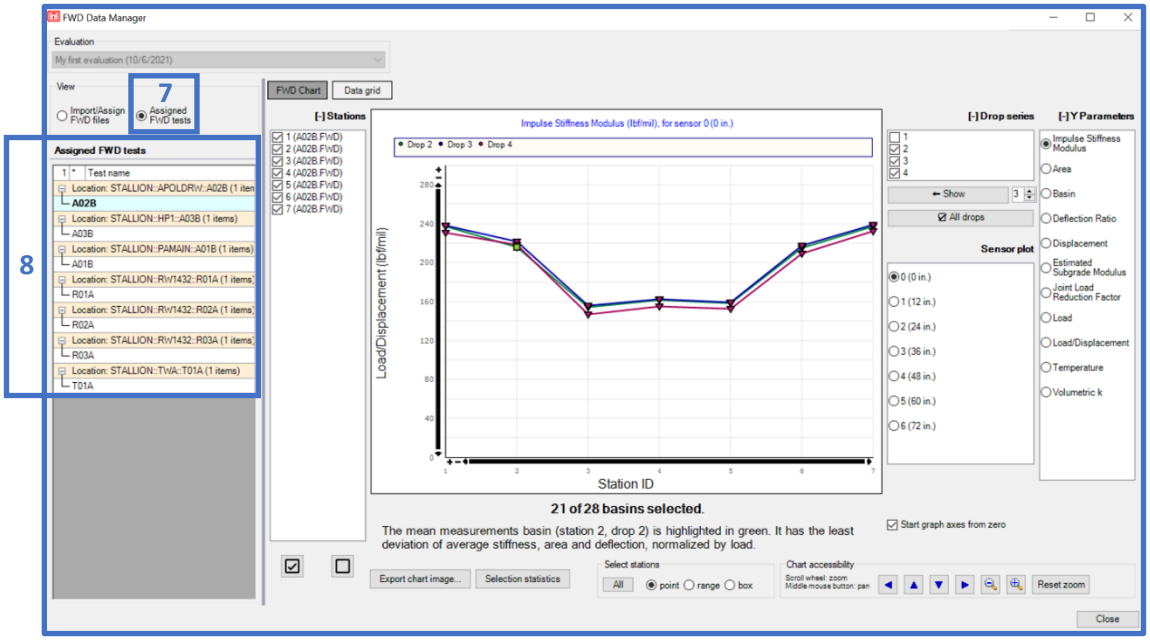
2. The successfully imported FWD/HWD files will be listed by File name.
3. Select Assign FWD files to sections to assign each imported file to the respective inventory section within the Assign FWD Data form.
4. To assign an FWD file to a section, select each individual file then drag it to the associated section in the Items assigned to inventory tree.
5. To automate this process, select Auto Assign. *Note: The individual FWD/HWD file must have the same file name as the associated inventory section name.*



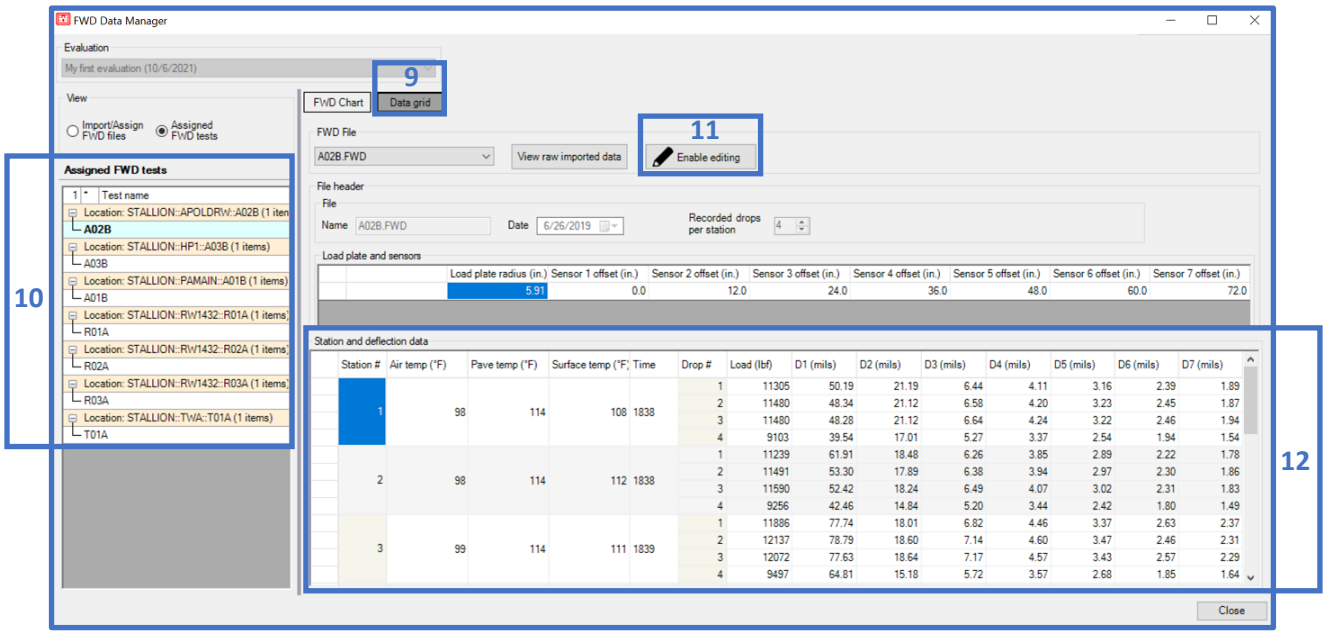
6. When Auto Assign is performed; a confirmation summary will display indicating the quantity of tests successfully assigned. This summary will also provide an indication of errors (if encountered).



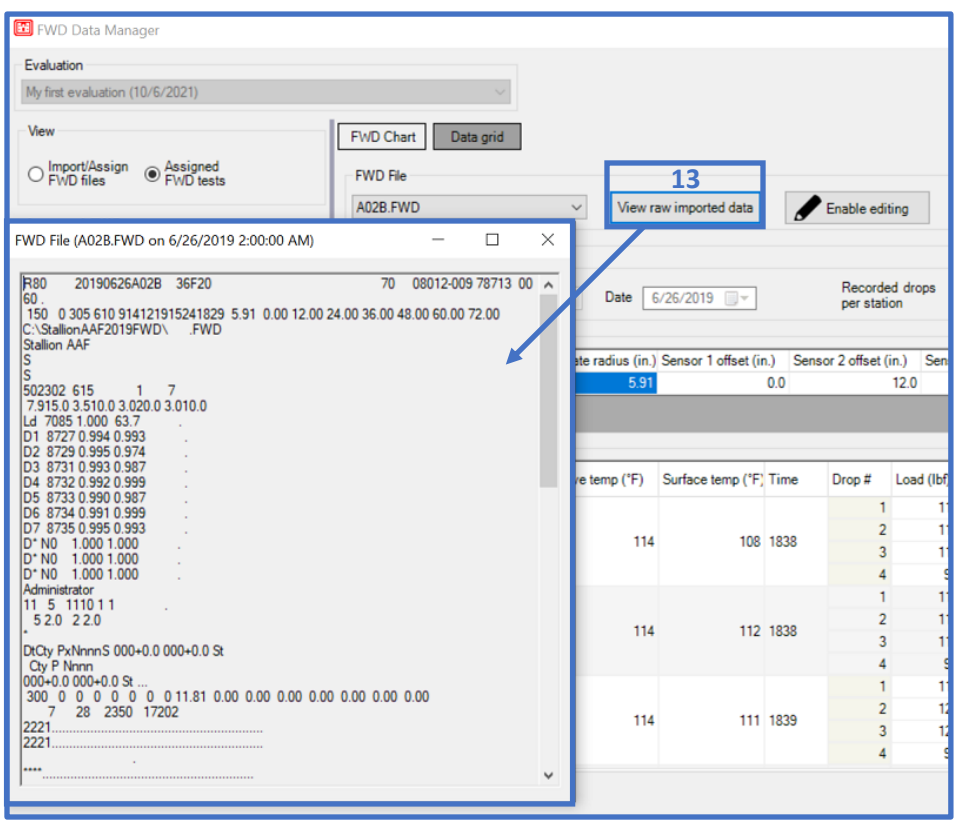
7. Select Assigned FWD tests to view the FWD/HWD tests assigned to their respective sections.
8. Assigned FWD/HWD items are displayed in the grid. The selected test name is in bold. To select another test, click on an item in the grid and the form will populate with the appropriate test data.



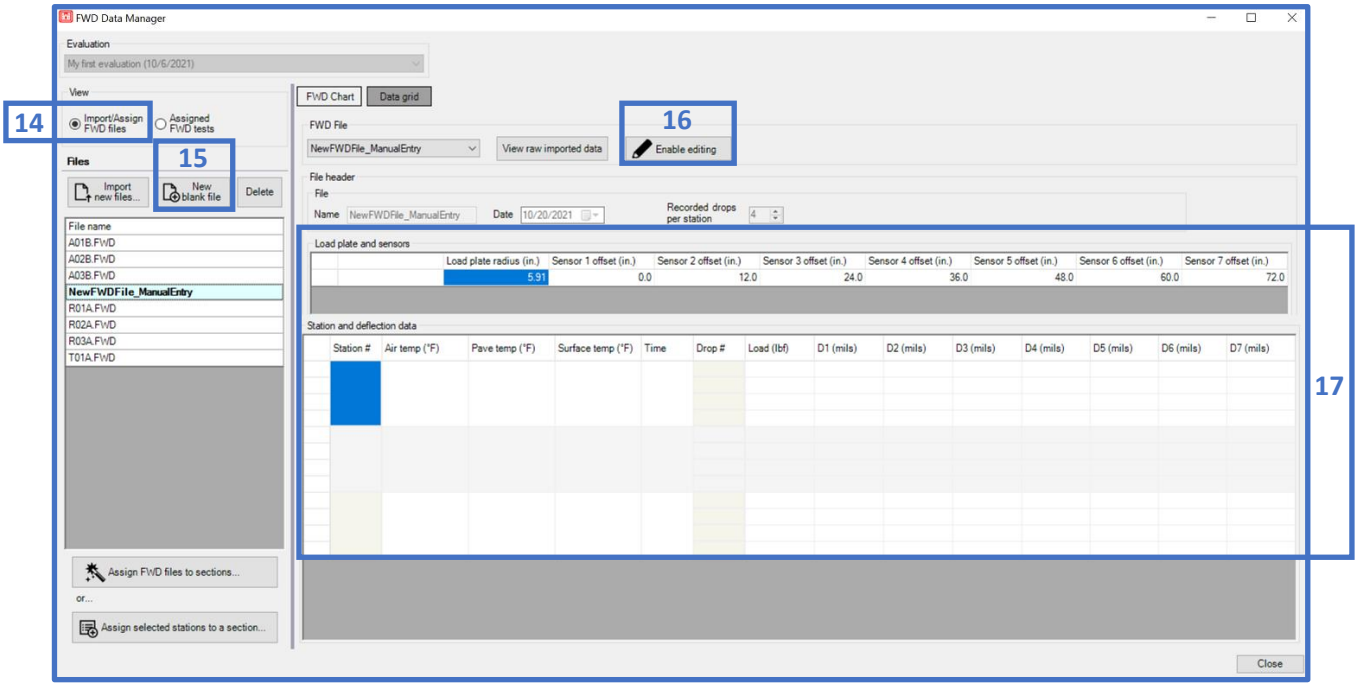
9. Select Data grid to switch to the dashboard for viewing/editing FWD/HWD data in tabular format.
10. Select the Test name to display the associated FWD/HWD data.
11. Select Enable editing to edit test parameters and data.
12. Deflection basin and logged temperature data can also be viewed/edited directly.



13. Select View raw imported data to display the raw FWD/HWD data.



14. To manually enter FWD/HWD data, select the radio button Import/Assign FWD files.
15. Select New blank file, then input the item/file Name and the total # of sensors.
16. Select Enable Editing to enable the data grid fields for parameter/data entry.
17. Input data for Load plate and sensors and Station and deflection data values.

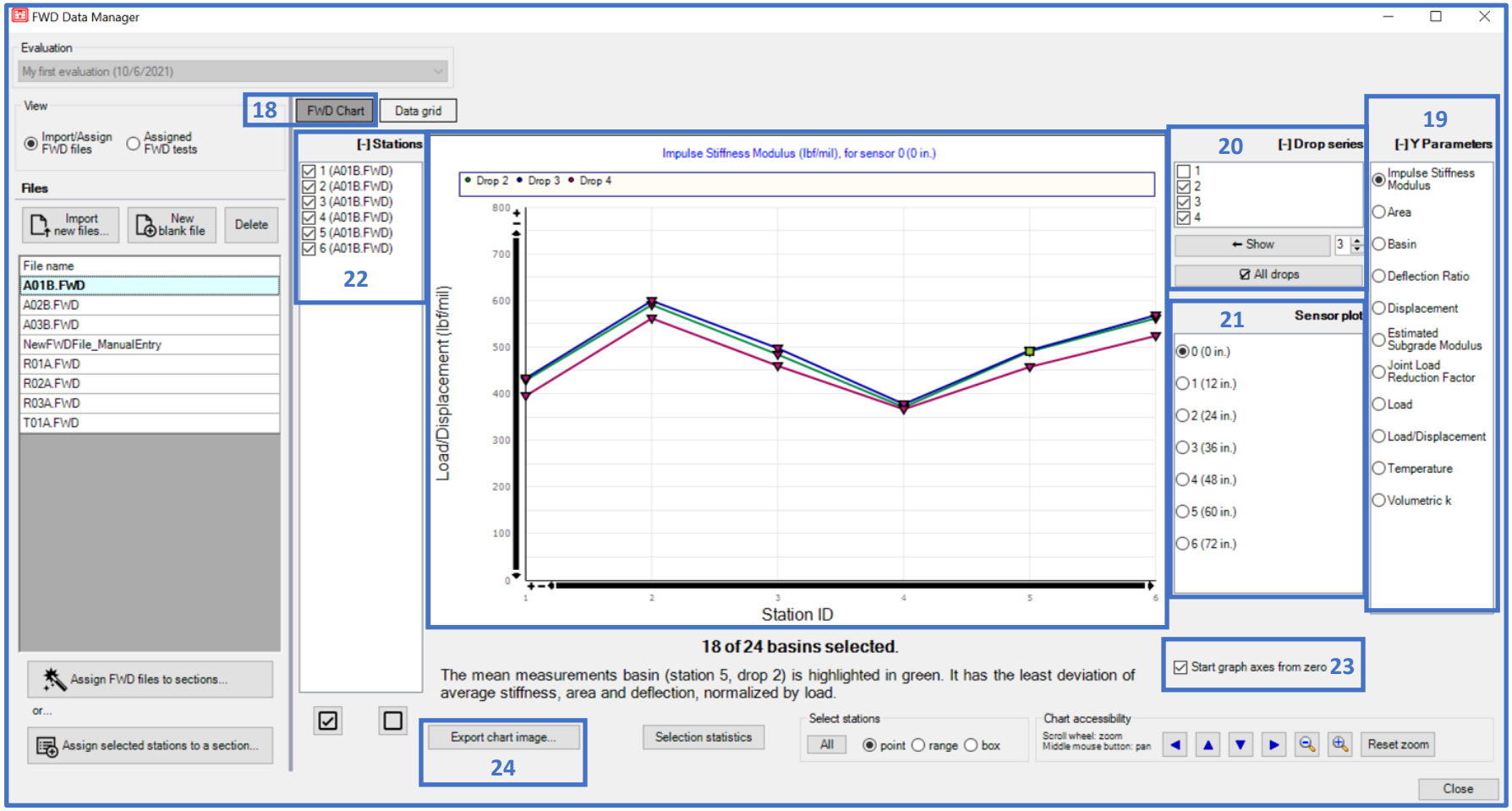


15.2.3 Interacting with the FWD/HWD Chart

The FWD data form provides an interactive dashboard to view and process individual FWD/HWD station data points. The form functions allow you to practice engineering judgement – coupled with provided descriptive statistical analysis tools and deflection basin parameter data visualization charts – to process FWD/HWD data points and perform QC/QA of collected data.

18. Select FWD Chart to view the FWD/HWD data assigned to each inventory section. The data visualization chart is interactive; pan the cursor over each data point to display the data label. The FWD Chart can be refreshed by toggling through each File name.
19. Click on the Y Parameters radio button of choice to display: Impulse Stiffness Modulus (ISM), Area, Basin, Deflection Ratio, Displacement, Estimated Subgrade Modulus, Joint Load Reduction Factor, Load, Load/Displacement, Temperature, or Volumetric K.

20. The chart can be filtered by selected Drop series. Select each check box to view/disable the drop series for data visualization and subsequent data selection for section assignment and/or statistics. *Note: Drop 1 is unchecked by default.*
21. The Sensor plot selection is enabled for: Impulse Stiffness Modulus, Deflection Ratio, Displacement, Joint Load Reduction Factor, Load/Displacement, and Temperature.
22. The chart can be filtered by selected Stations. Select each check box to view/disable Stations for data visualization and subsequent data selection for section assignment and/or statistics.
23. The data visualization y-axis chart will resize and apply a y-axis minimum value when Start graph axes from zero is disabled.
24. Select Export chart image to save the FWD chart to a .png file.

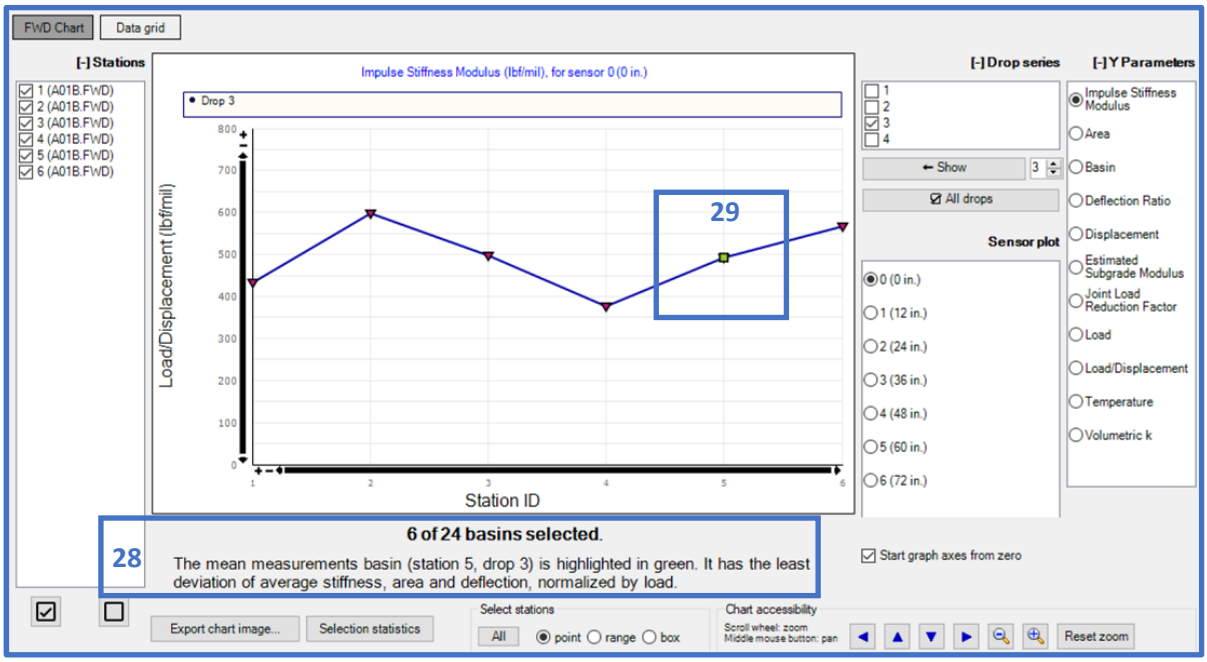

FWD Data Manager
Evaluation
My first evaluation (10/6/2021)
View
Import/Assign FWD files
Assigned FWD tests
Files
Import new files...
New blank file
Delete
File name
A01B.FWD
A02B.FWD
A03B.FWD
NewFWDFile_ManualEntry
R01A.FWD
R02A.FWD
R03A.FWD
T01A.FWD
Assign FWD files to sections...
or...
Assign selected stations to a section...
18
FWD Chart
Data grid
[-] Stations
1 (A01B.FWD)
2 (A01B.FWD)
3 (A01B.FWD)
4 (A01B.FWD)
5 (A01B.FWD)
6 (A01B.FWD)
22
Impulse Stiffness Modulus (lbf/mil), for sensor 0 (0 in.)
Drop 2
Drop 3
Drop 4
Load/Displacement (lbf/mil)
Station ID
20
[-] Drop series
Show
All drops
21
Sensor plot
0 (0 in.)
1 (12 in.)
2 (24 in.)
3 (36 in.)
4 (48 in.)
5 (60 in.)
6 (72 in.)
19
[-] Y Parameters
Impulse Stiffness Modulus
Area
Basin
Deflection Ratio
Displacement
Estimated Subgrade Modulus
Joint Load Reduction Factor
Load
Load/Displacement
Temperature
Volumetric k
18 of 24 basins selected.
The mean measurements basin (station 5, drop 2) is highlighted in green. It has the least deviation of average stiffness, area and deflection, normalized by load.
Start graph axes from zero
23
Export chart image...
24
Selection statistics
Select stations
All
point
range
box
Chart accessibility
Scroll wheel: zoom
Middle mouse button: pan
Reset zoom
Close

15.2.4 Selecting FWD/HWD Data Points and Viewing Representative Basin

The FWD Chart is interactive; enabling users to view the Representative Basin, and descriptive statistics based on user-defined FWD/HWD drop series, and individual station datapoints.

25. Use the Select stations options to select: All data points, point for individual selection, a range of points within established bounds, or box for points within the user-established "box" for inclusion within subsequent descriptive statistics calculations of the parameter of interest.
26. The chart selection method is initialized by using the mouse to select/exclude individual points and/or establish the range bounds (range or box).
27. Select Selection Statistics to display the descriptive statistics for the selected data points. The calculated statistics are also dependent on the selected Stations, Drop series, and Sensor plot.

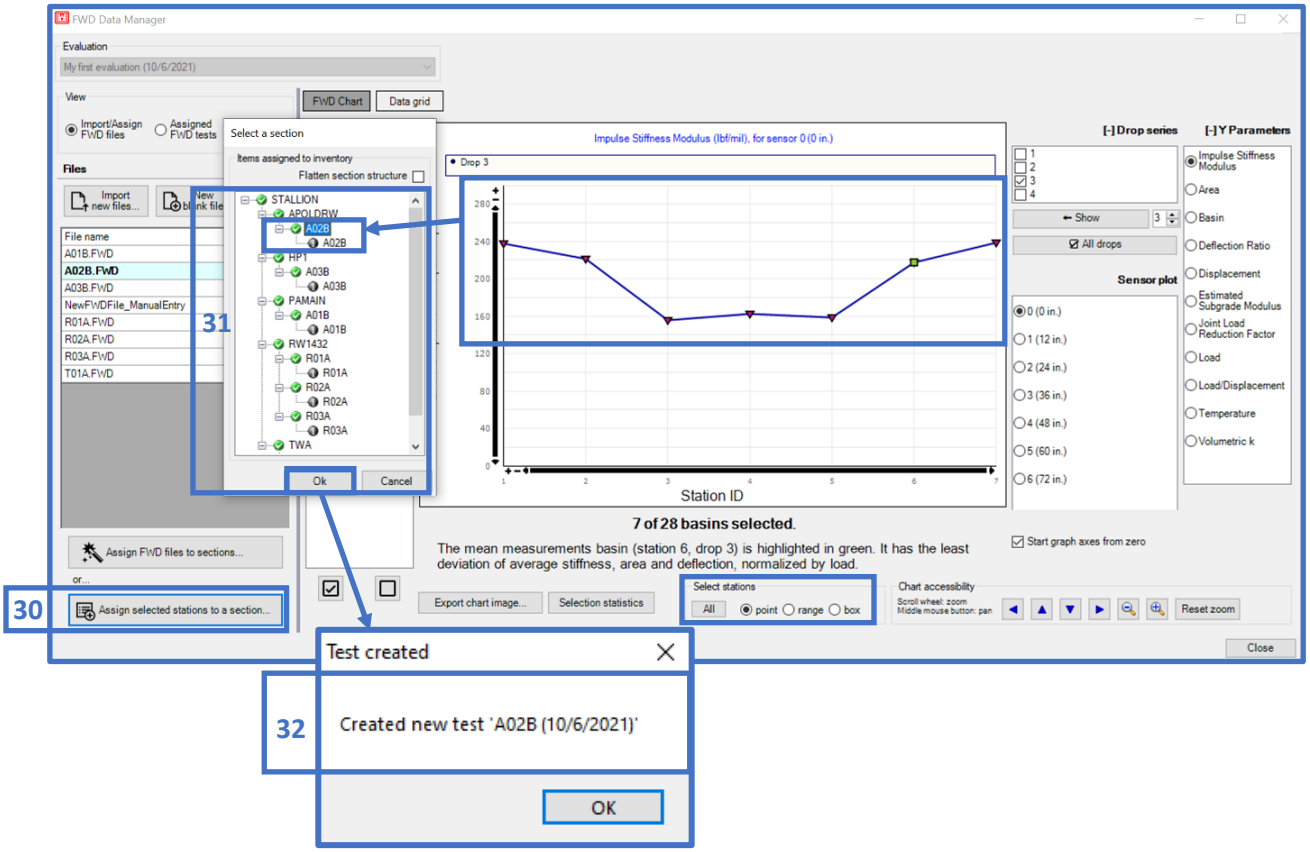
28. Based on the selected points and Y Parameters, the calculated Representative Basin will be visualized. The calculations associated with the Representative Basin are also dependent on the selected Stations and Drop series. The Representative Basin calculation is summarized as "the least deviation of average stiffness, area and deflection, normalized by load."
29. The Y Parameters datapoint-data marker associated with the calculated representative basin is highlighted as a green square and is visible as the user toggles through the parameter options.



15.2.5 Assigning Selected FWD/HWD Data Points to Section Inventory

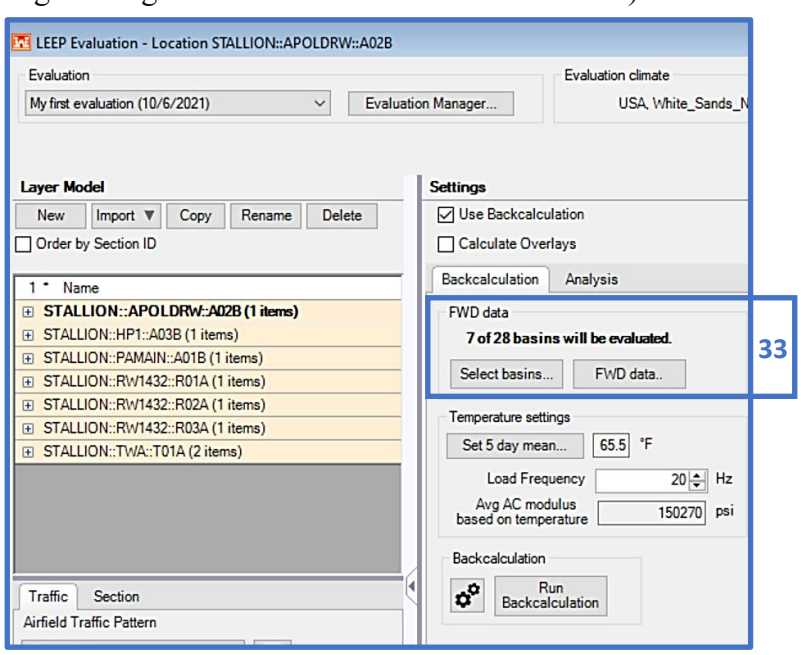
The individual FWD/HWD station data points selected using the Select Stations feature can then be assigned to inventory sections for subsequent use in LEEP backcalculation and analyses. The Representative Basin that is obtained based on the selected FWD/HWD station data points is also carried over for LEEP evaluation backcalculation and analyses.

30. Based on the selected points, Stations, and Drop series, the associated deflection basins can be assigned to an inventory section. Select Assign selected stations to section.
31. Click on a section within the Select a section form to assign the deflection basins. Select Ok to complete this process.
32. The message shown stating "Test created" indicates successful assignment.



15.2.6 Viewing Assigned FWD/HWD Data Points in LEEP

33. Navigate to the LEEP evaluation form; the assigned basins that to be evaluated during LEEP backcalculation will be displayed in the FWD data section (this is indicated by the message stating "X of XX basins will be evaluated.").



15.3 FWD Data Example

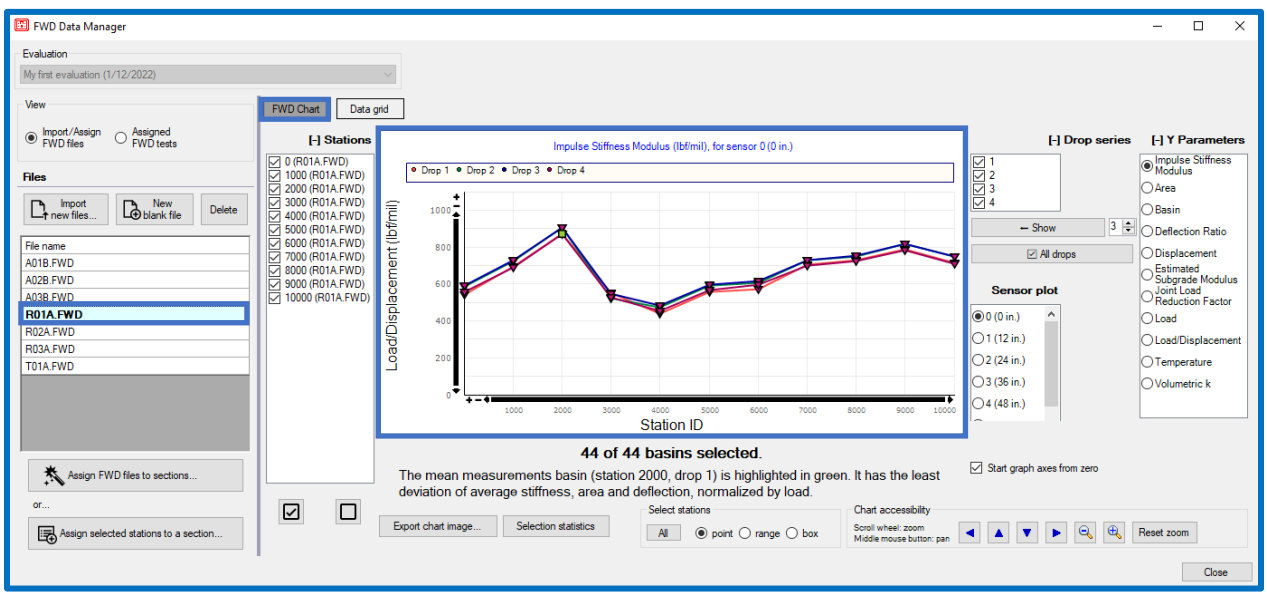
15.3.1 Perform Analysis of Pavement Using Deflection Basin Data

Pavement Engineer, Jane, at Stallion Army Airfield, observed increased pavement surface deterioration throughout Section R01A. These distresses have progressed more rapidly in the last 5-months. Jane will perform a structural evaluation with a Heavy Weight Deflectometer to gauge how these distresses may affect the service life and structural performance of the pavement section. She will use the HWD data (R01A) to perform data processing and assessment prior to LEEP Backcalculation and analysis.

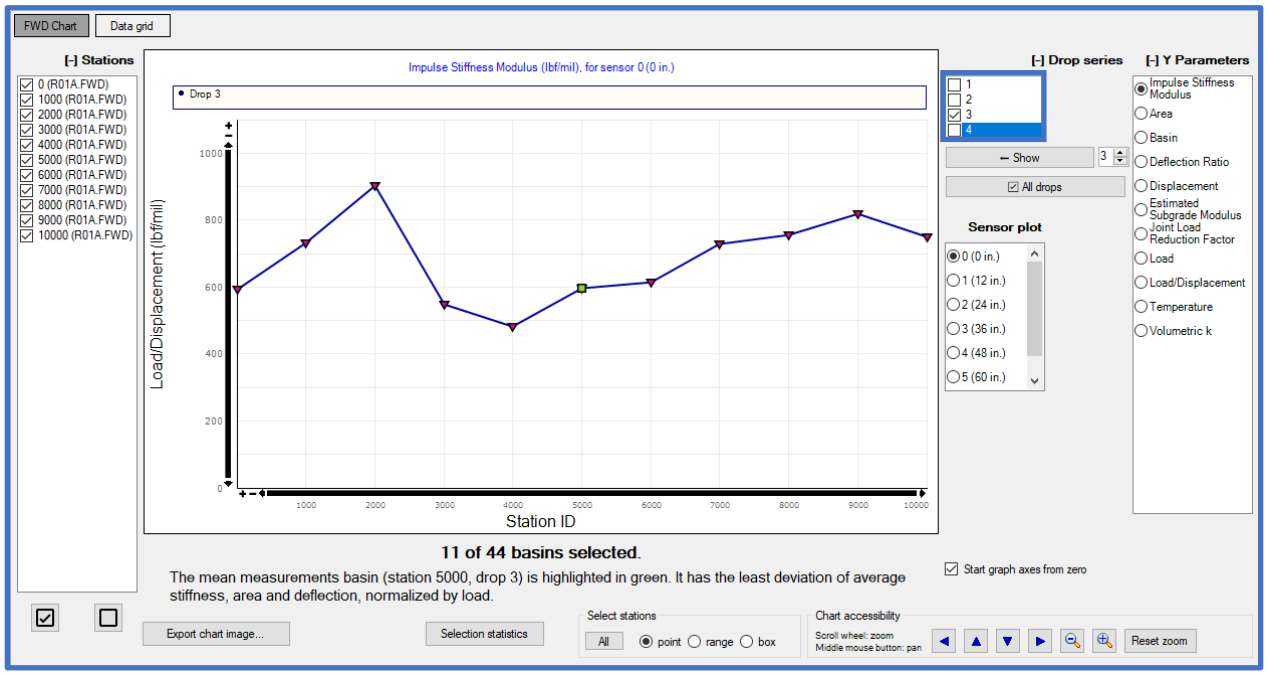
Step 1. Jane defines the pavement inventory, uploads the HWD data, and assigns data to inventory section: Stallion R01A. Instructions to perform this step-by-step process are outlined in sections 15.1 and 15.2.

Step 2. Jane toggles to the FWD data form to view the FWD Chart for section R01A.

Step 3. Given that Drop series 1 and 2 are considered as *seating drops*, they will not be considered for subsequent analysis.



Step 4. Jane uses the Drop series option to remove Drop series 1 (seating drop), 2 (seating drop), and 4 from the analysis. Drop series 4 is removed from analysis because she uses her engineering judgement to assume that the 4th drop series could possibly impose a minimal level of damage on the pavement; sufficient enough that she wants to remove any skew potential to the structural analysis results. As shown in the figure below, accepting the 3rd Drop series will serve as the analysis deflection data set for this case.

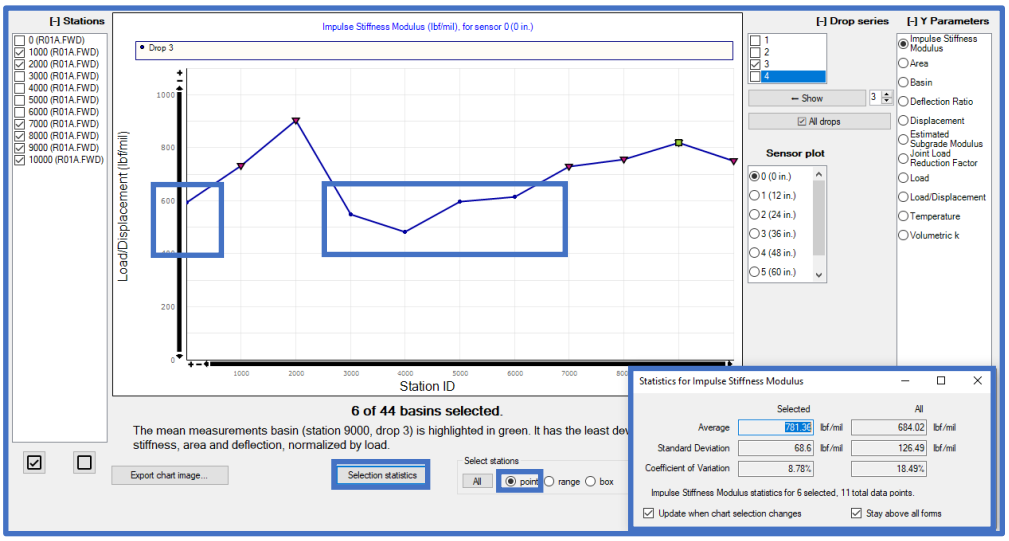


Step 5. Observing the deflection basin parameter trends by selecting Y Parameters on the FWD Data form, Jane immediately identifies that the ISM series is reflecting lower ISM values at five different stations of the section. Comparing to a distress survey, these stations spatially coincide with locations of the pavement that exhibit significantly higher levels of deterioration. ISM is the force required to displace the pavement by one mil, as measured directly under the load. By this definition, Jane observes that the lower ISM values at these five stations are consistently reflecting a lower level of stiffness/structural integrity when compared to the other stations. Jane suspects that the ISM deflection basin parameter may be a good indicator of displaying lower stiffness in the pavement considering that it spatially coincides with higher levels of distress.

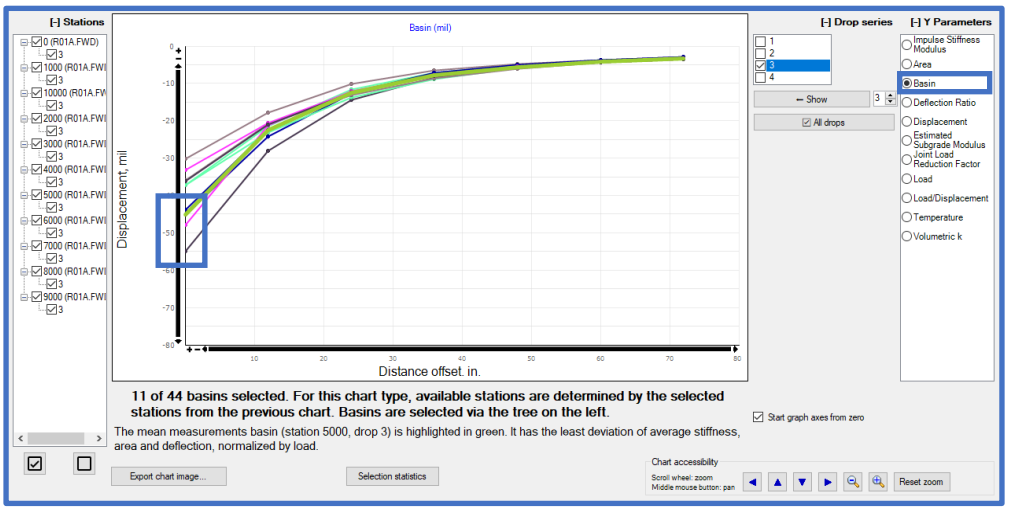
Step 6. Jane then uses the Select stations point function to select these five distinct stations (that are exhibiting low ISM values) on the FWD Chart with the Y Parameter set to Impulse Stiffness Modulus. See the figure below to view these selected stations.

Step 7. Jane selects Selection Statistics to view the descriptive statistics of this ISM data point selection in comparison to all the stations. There are comparative descriptive statistics shown for the Selected stations, and for All the stations.

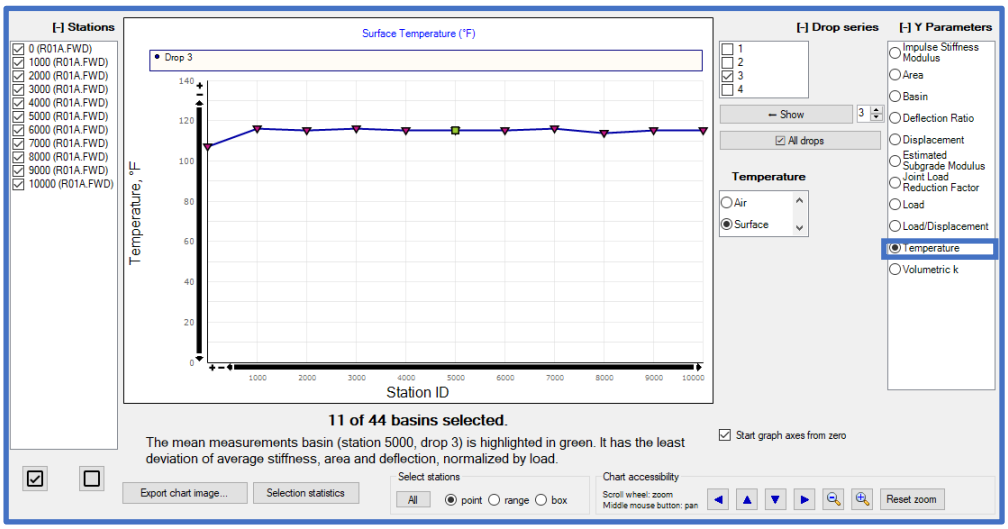
Step 8. Viewing and comparing the Coefficients of Variation (CV), it is clear that there is significant variability of the ISM trends when comparing $CV_{Selected}$ 8.78% to CV_{All} 18.49%. A preliminary conclusion could be drawn that the low ISM values (i.e., stiffness) coinciding with the highly distressed areas display relatively low variability with respect to one-another, while imposing significant variability when observed with the entire sample.



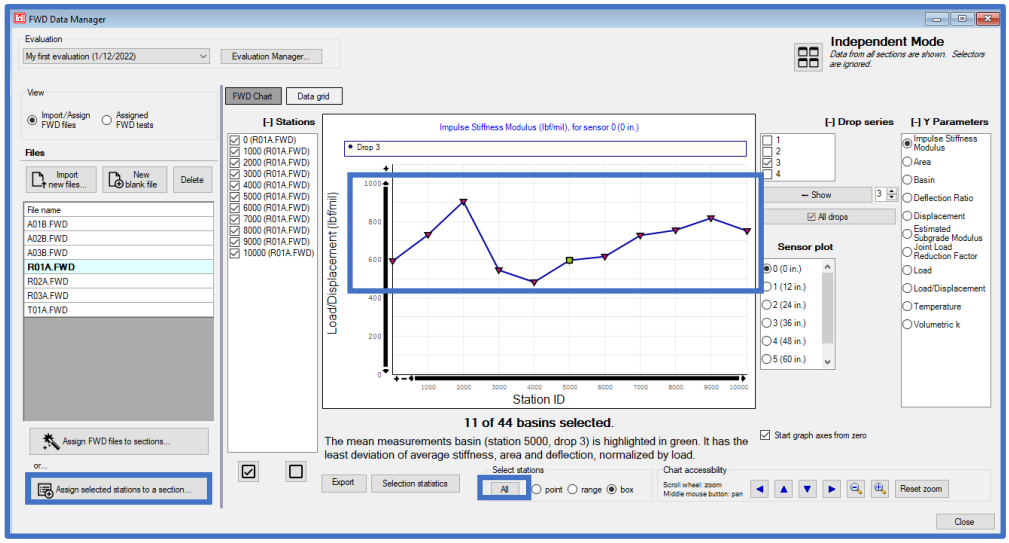
Step 9. Jane then toggles to the Basin Y Parameters to view the respective Deflection Basins. She observes that the deflection basins for these five stations with low ISM values exhibit higher displacement values for D1 when compared to the other stations. The displacement values for D2-D7 seem to be fairly consistent across all the stations.



Step 10. Jane checks the surface temperature trend (as recorded by the HWD system) to ensure that observations made on the deflection basin were not affected by significant temperature fluctuations. Observing the temperature trend, Jane confirms that the temperature on the pavement surface during data collection is mostly consistent, and not imposing any significant variability on the results. There may be some variability introduced to the surface modulus imposed by the temperature fluctuation from the first station.



Step 11. To perform subsequent modulus backcalculation and structural analysis in LEEP evaluation (to observe the backcalculated moduli, Allowable Gross Loads (AGL), and allowable passes) Jane selects All for Select Stations, followed with Assign selected stations to a section: R01A. She will perform a comparative analysis with these outputs in LEEP evaluation to observe how these highly distressed areas will affect pavement performance and structural integrity.



16 DCP Data

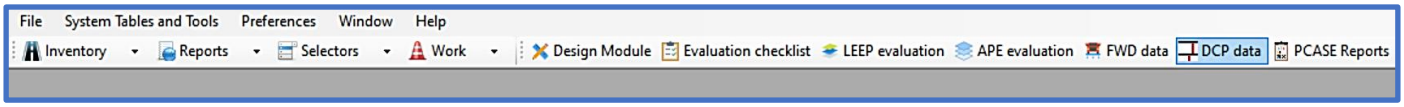
The DCP data form serves to process and analyze Dynamic Cone Penetrometer (DCP) readings. The readings from a single or multiple series of DCP data can be processed to calculate estimated California Bearing Ratio (CBR), Modulus of Subgrade Reaction (k), Modulus of Elasticity (E), and Bearing Capacity; with profile depth. The data can also be processed graphically in order to set layer boundaries along the profile depth. These layers can be imported for subsequent LEEP and APE analyses.

Prior to beginning a new evaluation, ensure that you have opened or created a database to store the evaluation within (database name is displayed on the bottom-left of the main window). For instructions on how to import or create a database; reference Chapter 2, Section 2.2 New/Import.

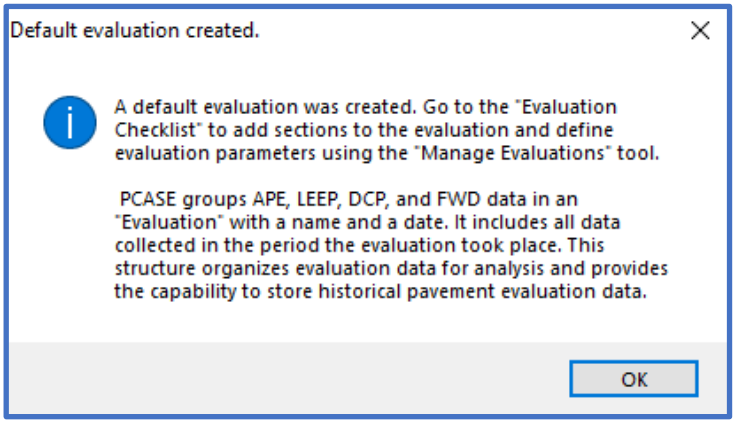
If you intend to import pavement structures; ensure you have defined your inventory (unless you will be creating sections Ad Hoc); reference Chapter 7, Section 7.1 Define Inventory.

16.1 Getting Started

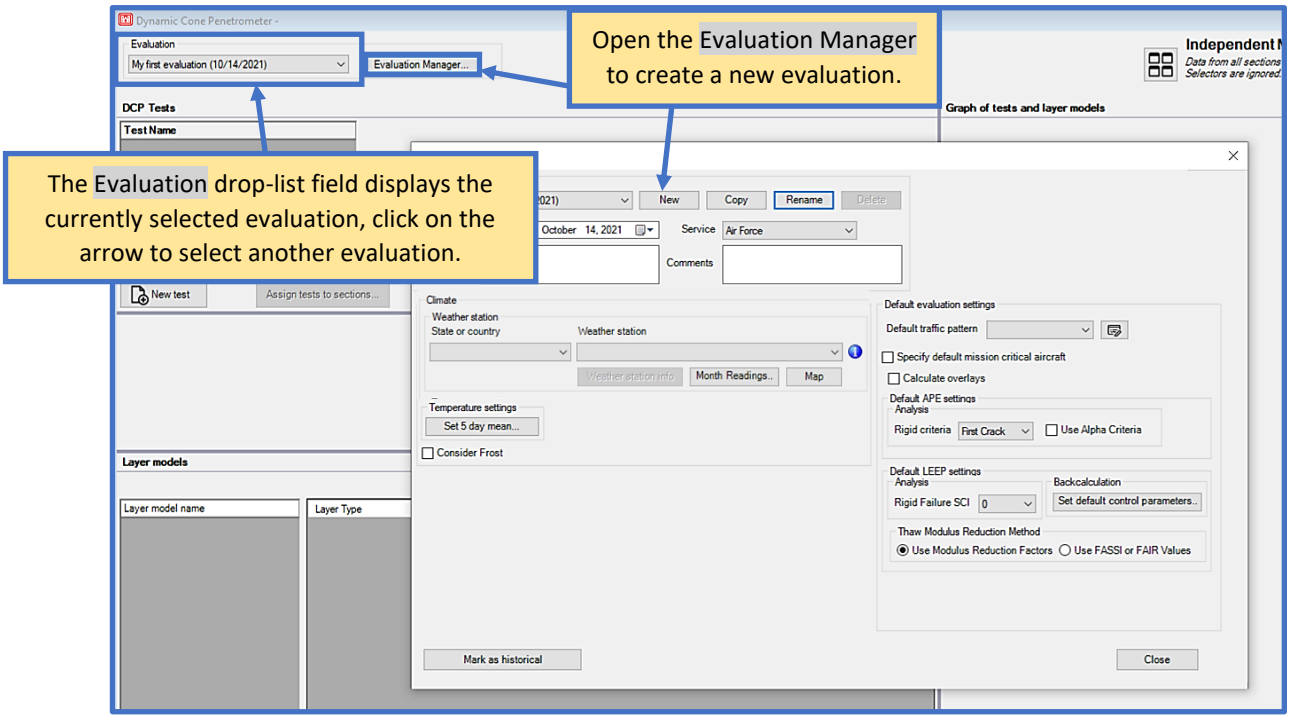
Select DCP data on the PCASE 7 toolbar to open the evaluation tool.



If you have not imported or created an evaluation in the current database, the message below will display to indicate a default evaluation was created. Click OK to continue.

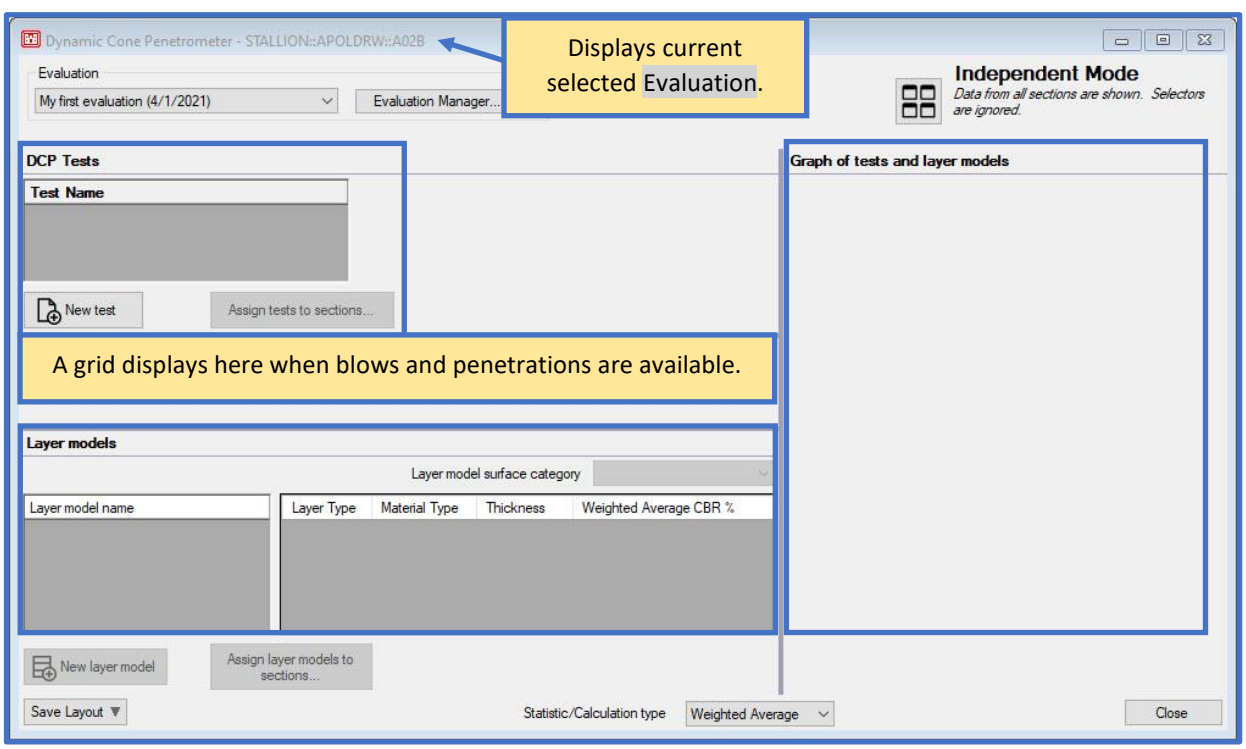


You can rename the default evaluation or create a new evaluation by selecting Evaluation Manager (accessible through the DCP data form). If you have historical data that you've imported from an earlier version of PCASE or created an evaluation in the Evaluation Checklist, use the drop-down list to select the evaluation.



16.2 DCP Data form

As shown in the blank form below, the DCP Data form is organized in three sections; DCP Tests, Layer Models, and Graph of tests and layer models. The Blows and Penetration grid displays when data is provided,



16.2.1 Evaluation Manager

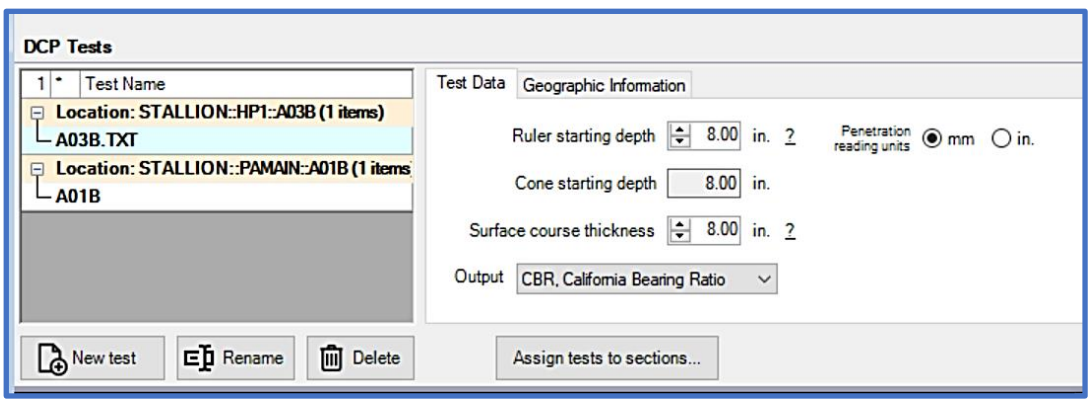
Evaluation Manager serves to establish global analysis parameters. To navigate Evaluation Manager; reference Chapter 12 Evaluation Checklist, Section 12.3 Evaluation Manager.

16.2.2 DCP Tests

The DCP Tests panel includes controls to manage test data. The grid on the left lists test names for the currently selected Evaluation. Below the grid are buttons which allow you to create a New test, Rename an existing test, or Delete a test. The Test Data tab consists of fields that allow you to input starting depth and surface course thickness values; you can also modify the Output option and Penetration reading units. *Note: Changing units using Penetration reading units, only converts units displayed in the Cumulative penetration reading column. Units displayed within the entire DCP Data form can be changed in Preferences.*

Tests can be assigned to inventory sections using the Assign tests to sections tool.

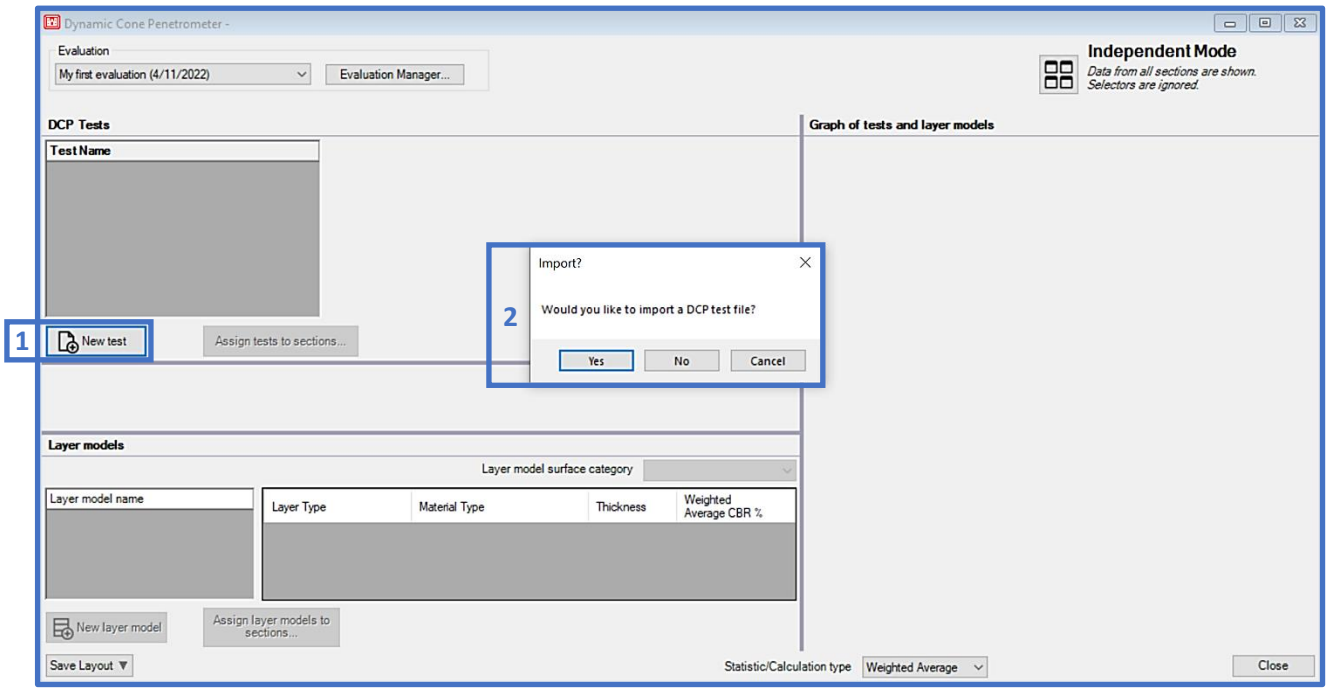
The Geographic Information tab contains fields for location information. This function has not been fully implemented. In a future version the fields will populate with data derived from imported tests.



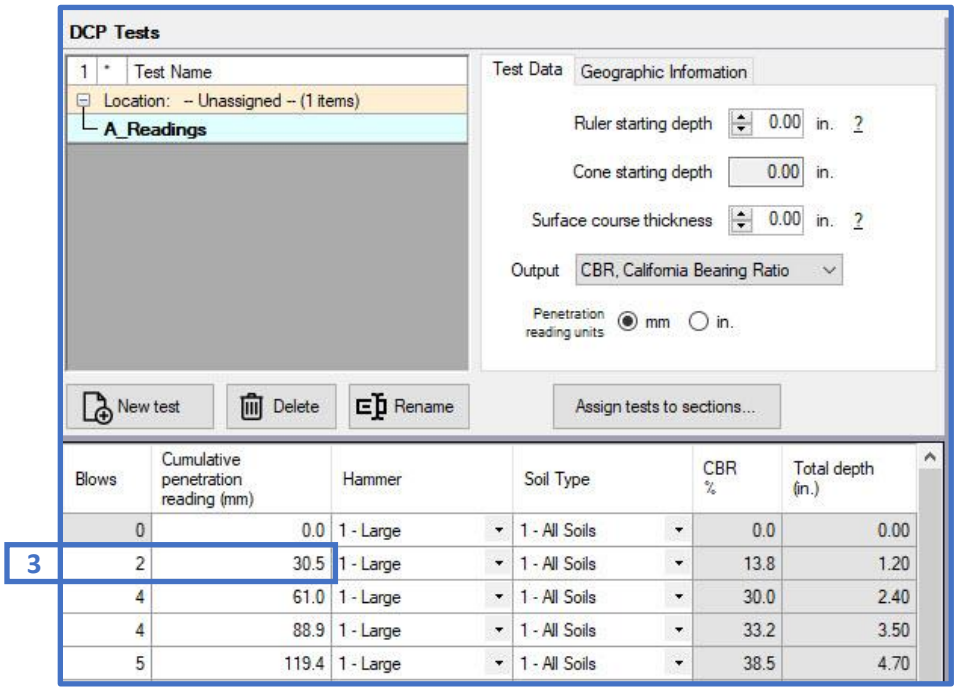
The Blows and Penetration grid displays Blows, penetration readings, Hammer size, Soil Type, output type, and Total depth for each selected test. Values can be edited directly in the grid, except read-only values (cells colored gray).

Blows	Cumulative penetration reading (mm)	Hammer	Soil Type	CBR %	Total depth (in.)
0	0.0	1 - Large	1 - All Soils	0.0	6.00
3	807.0	1 - Large	1 - All Soils	0.6	37.77
4	833.7	1 - Large	1 - All Soils	34.9	38.82
5	863.7	1 - Large	1 - All Soils	39.2	40.00
4	888.7	1 - Large	1 - All Soils	37.5	40.99

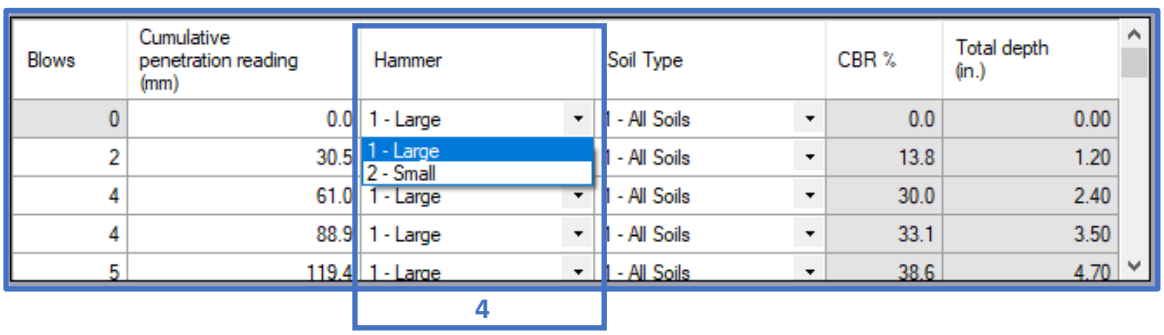
1. Select New Test to create a new test file.
2. Select Yes to import a DCP test file or No to manually enter penetration readings.
   a. If Yes; navigate to the location of files. You can select a single DCP test file for import or multiple files to batch import. Select Open to complete the import process.
   b. If No; enter a unique descriptive name within the Test Name form, then select OK.



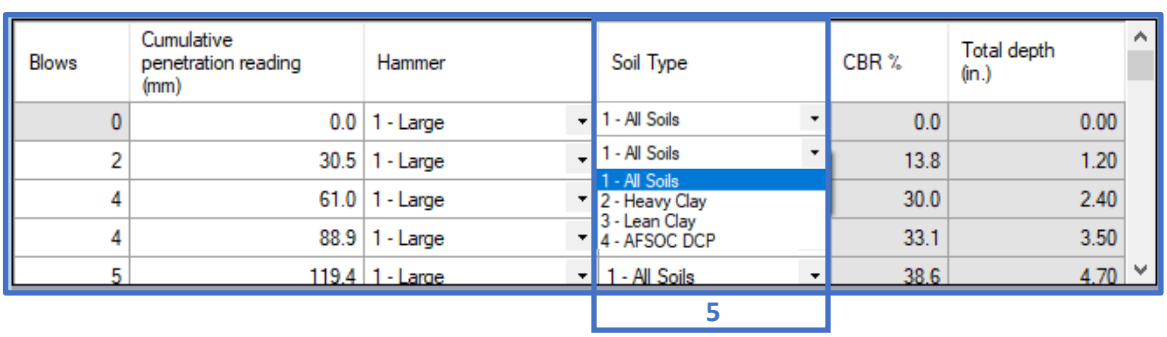
3. To manually input DCP readings, select the second cell in the Blows column and enter a value. To input the associated Cumulative penetration reading value, you can either select the cell field with your cursor or press Tab on the keyboard to toggle to the next field. Once the Blows and Cumulative penetration reading values are entered for a row press Enter or Tab on the keyboard to generate a new row.



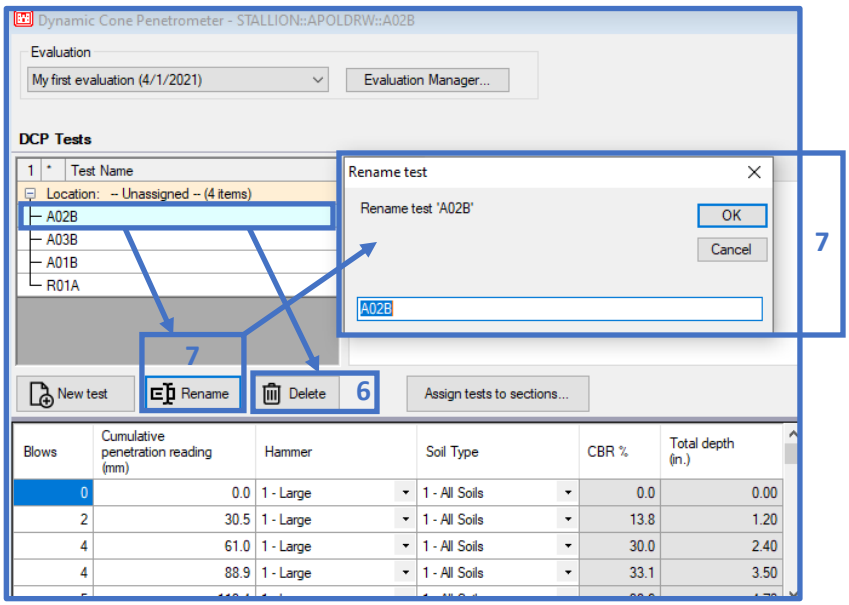
4. Select the Hammer size: 1- Large (17.6-lb) or 2-Small (10.1-lb).



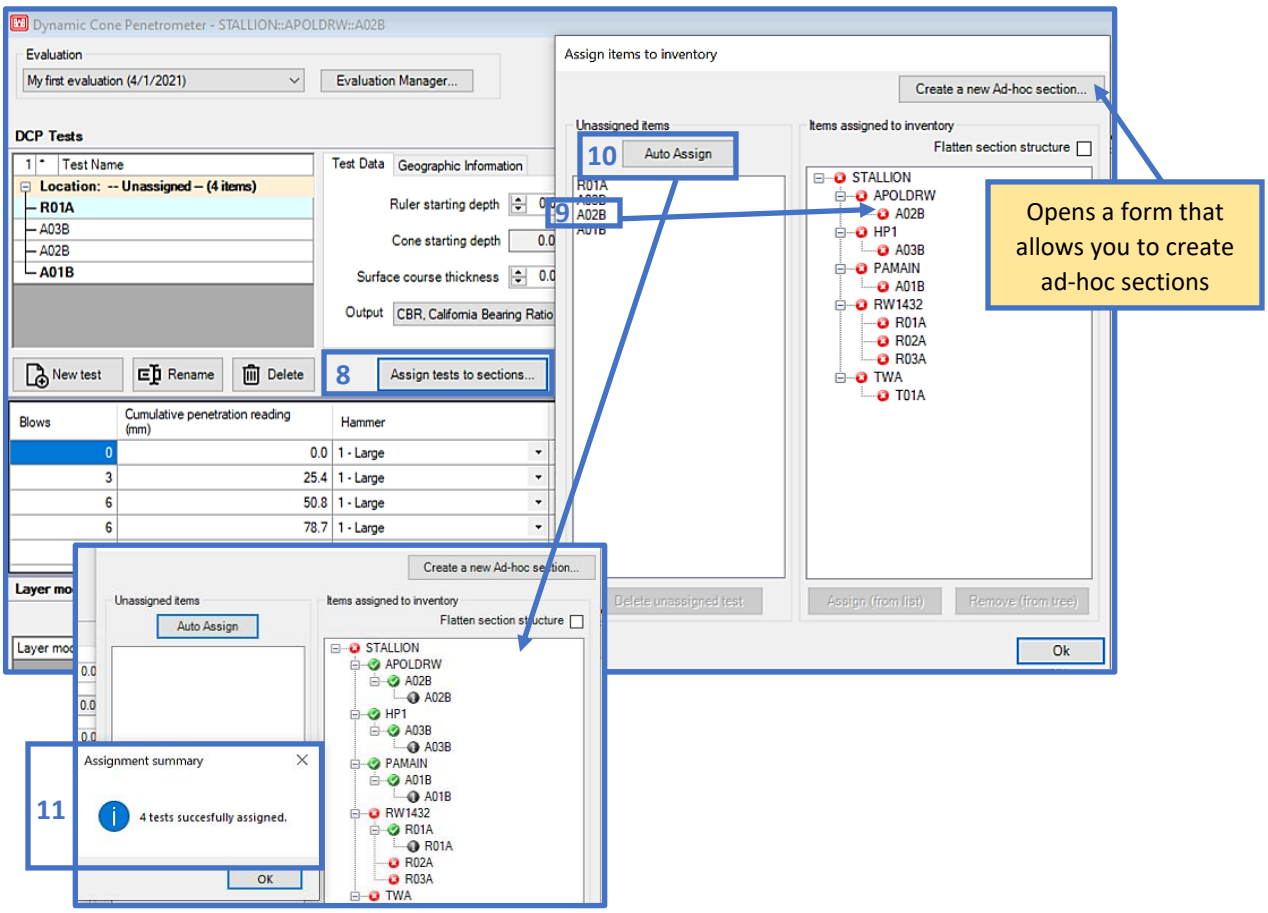
5. Select the Soil Type: 1-All Soils, 2-Heavy Clay, or 3-Lean Clay.



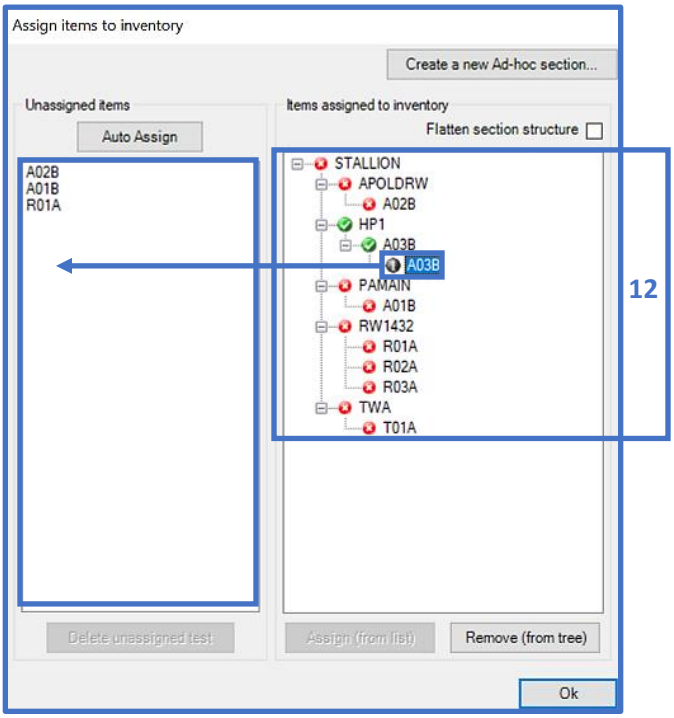
6. If you wish to remove a test; select an item from the DCP Tests grid, then click on the Delete button.
7. To rename a test from the DCP Tests inventory; select a Test Name, then click on the Rename button and follow the prompts to update the current name.



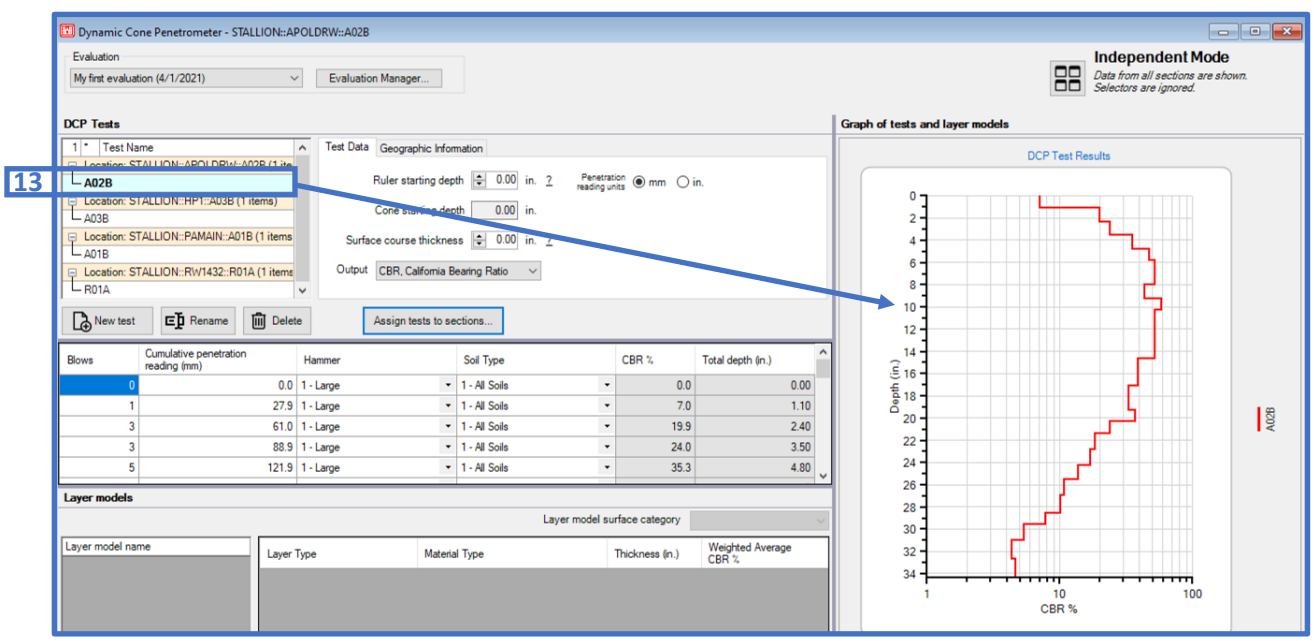
8. Select Assign tests to sections to assign individual DCP test files to sections.
9. Once the Assign items to inventory form opens, drag each individual DCP test file in the inventory to the associated network section.
10. Select Auto Assign to automatically assign multiple DCP tests files to the appropriate section. *Note: The DCP test file name must be consistent with the section name for Auto Assign to be successful.*
11. A completed Auto Assign will provide an assignment summary. Select OK to close the window.



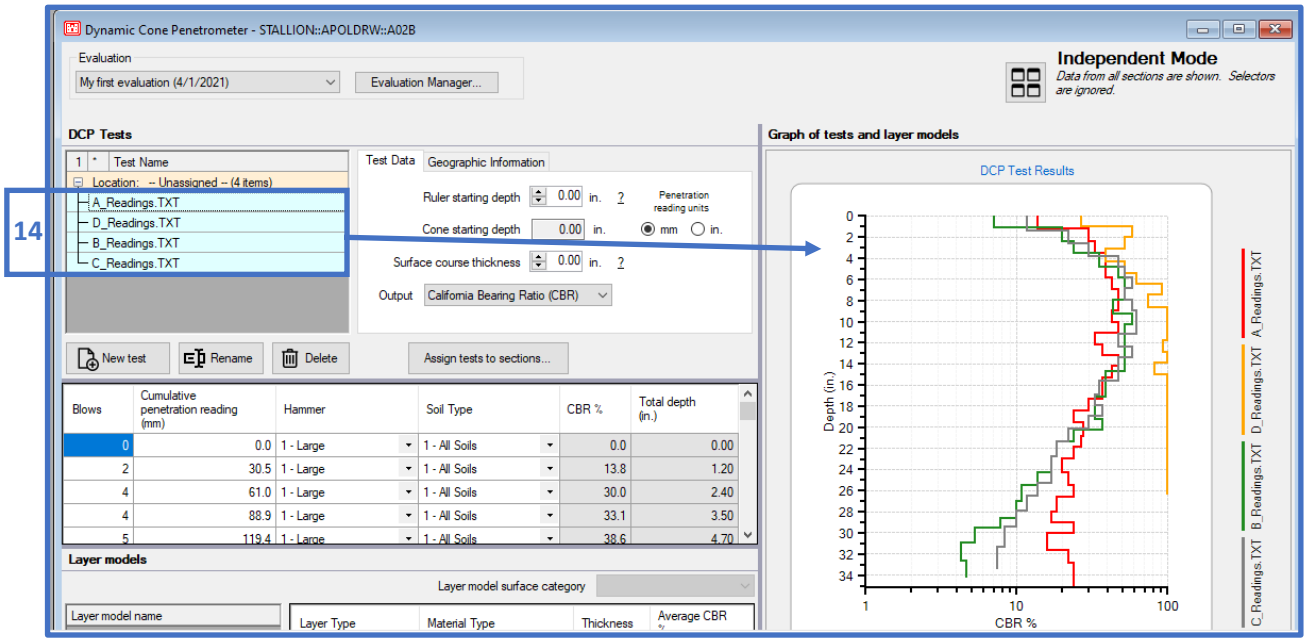
12. You can also remove assigned DCP test files from sections by selecting a section from the Items assigned to inventory box and dragging it to the Unassigned items box.



13. To visualize an individual DCP profile, select a DCP Test Name; the plot will display on the DCP Test Results chart.

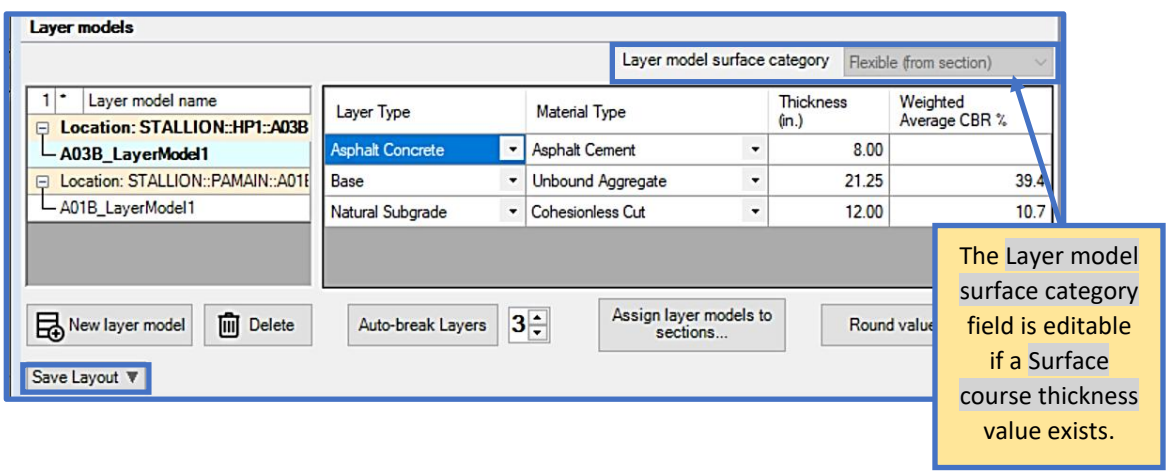


14. Multiple series of DCP test files can be visualized on the DCP Test Results chart by selecting a DCP test file from the Test Name list, then dragging your cursor downward until you're satisfied with the selection. *Note: Selected Test Name cells will become highlighted in blue and bold.* You can also select multiple files by maintaining Ctrl on a keyboard and selecting each individual file.

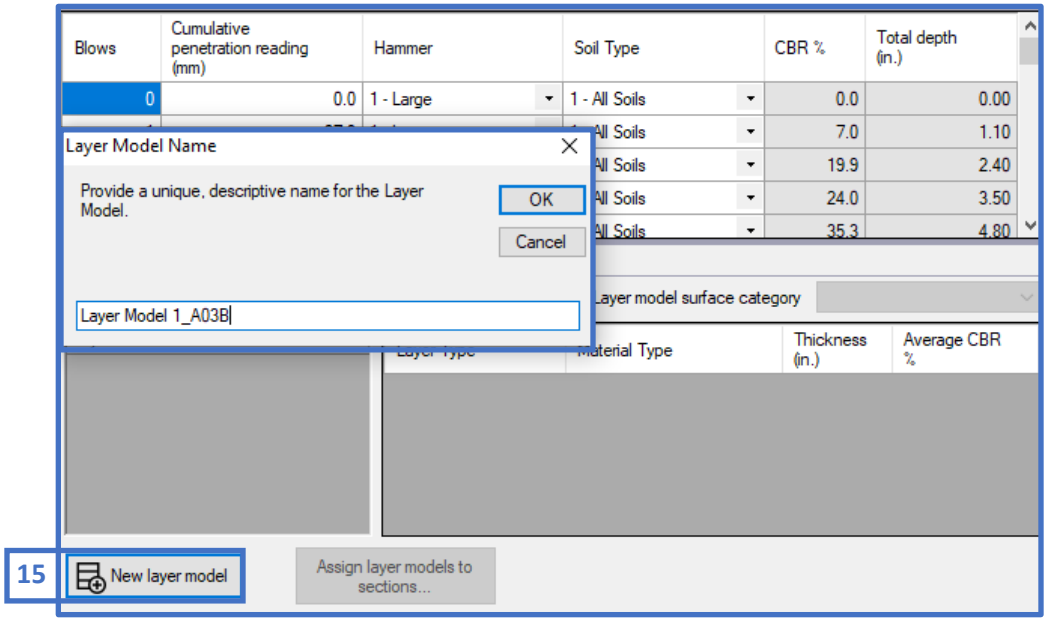


16.2.3 Layer models

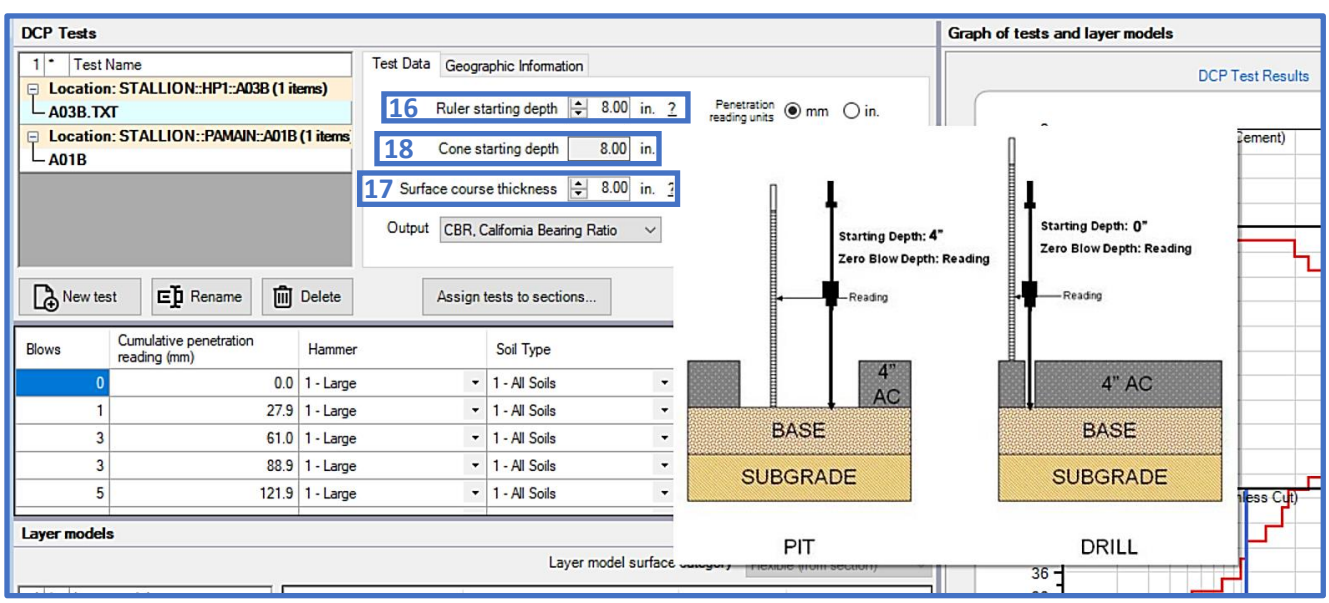
The Layer models panel consists of a grid on the left that lists each Layer model name, functions for creating and deleting layer models, and a layer model grid with associated grid functions beneath. The Save Layout function allows you to adjust the panels within the form and save a configuration. You may also delete a previously saved layout by clicking on the arrow to select the Delete saved layout option.



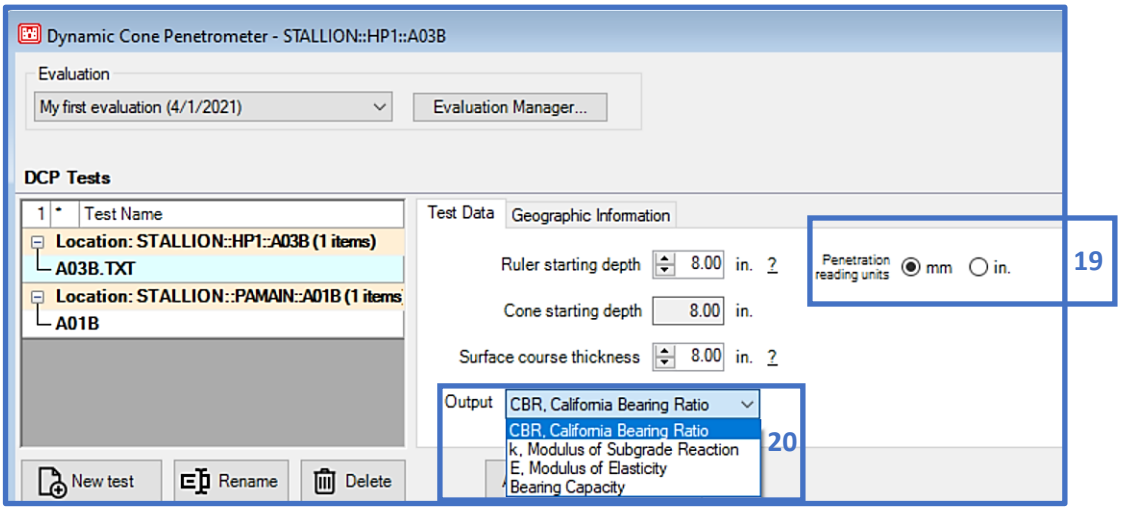
15. To create a layer model, select New layer model, then input a distinctive name within the Layer Model Name field. As discussed in steps 13 and 14; select the associated DCP Tests for the corresponding layer models. *Note: Multiple layer models can be created; each with unique DCP Tests selections.*



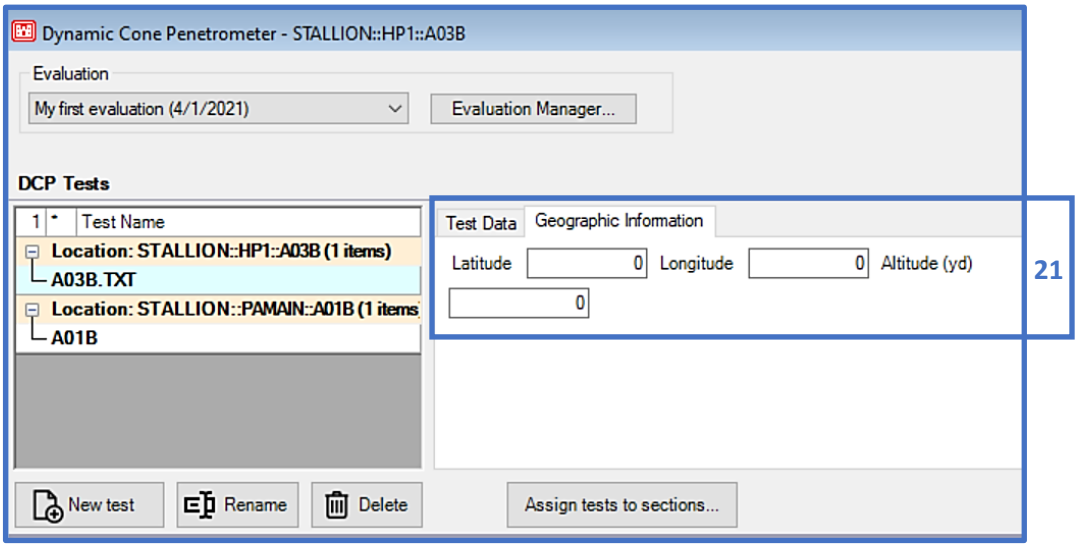
16. Prior to performing a DCP analysis, establish the utilized Ruler starting depth convention that was employed during data collection. Roll over the 2 icon to view a diagram of the accepted conventions within PCASE 7.
17. The Surface Course Thickness value auto populates based on the inputted Ruler starting depth value; the field is editable if you wish to enter another value. Refer to the tool-tip for a diagram of accepted conventions based on the pavement structure and ruler placement.
18. The Cone Starting Depth field is displayed, but cannot be edited.



19. Toggle between the radio buttons to select the appropriate measurement unit for Penetration reading units. The selected unit will only be reflected in the Cumulative penetrating reading column cells.
20. Select the output parameters for the DCP analysis: California Bearing Ratio (CBR), Modulus of Subgrade Reaction (k), Modulus of Elasticity (E), and Bearing Capacity.

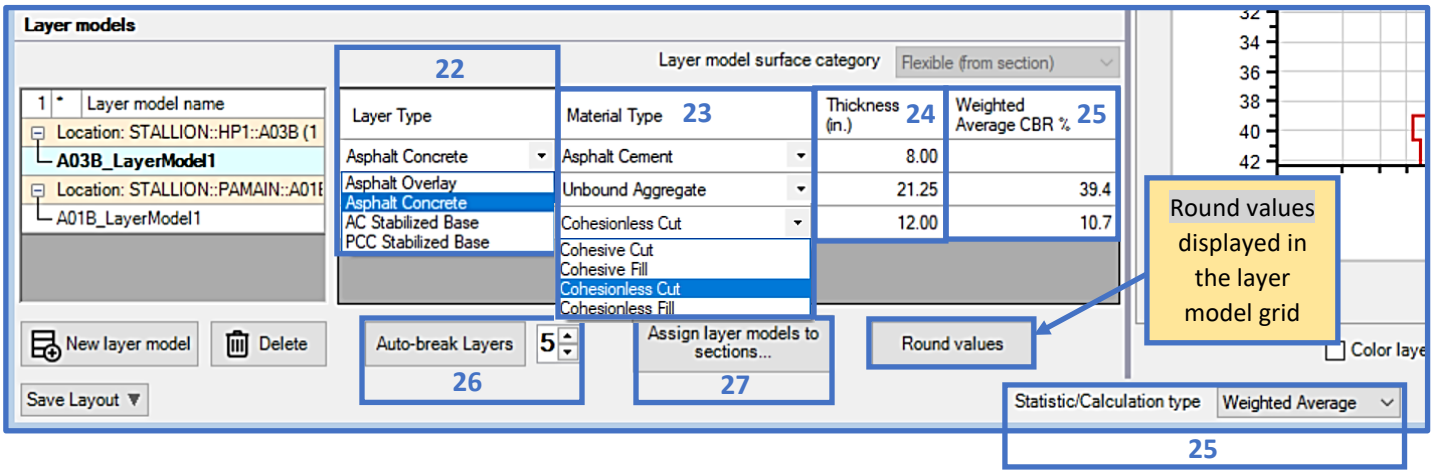


21. A form to assign GPS coordinates to each DCP test is available under Geographic Information. However, this function has not been fully implemented yet.



22. When a layer model is created, the Layer Type drop-lists in each grid cell can be used to select different layer types.
23. Select the Material Type for each layer using the corresponding drop-list cell.
24. The thickness for each layer is reflected in the Thickness column. This field is dynamic and will change when you move the boundary layers on the Graph of test and layer models chart. Likewise, a data entry change in the Thickness field will be reflected within the Graph of test and layer models chart.

25. Select the Statistic/Calculation type (calculated Average, Weighted Average, Minimum, or Eighty-fifth percentile) to display results in terms of the selected output parameter: CBR, k, E, Bearing Capacity).
26. An automation algorithm is available to identify separate layers based on deviation in the CBR, k, E, or Bearing Capacity with profile depth. Input (or scroll to) the total number of layers to use for the algorithm, then select Auto-break Layers to initiate the function. The output layer configuration displays in the layer model grid and on the Graph of tests and layer models chart.
27. Assign layer models to sections to assign layer structures to sections for subsequent pavement analysis. Ad-hoc sections can also be created from the Assign layer models to sections form.

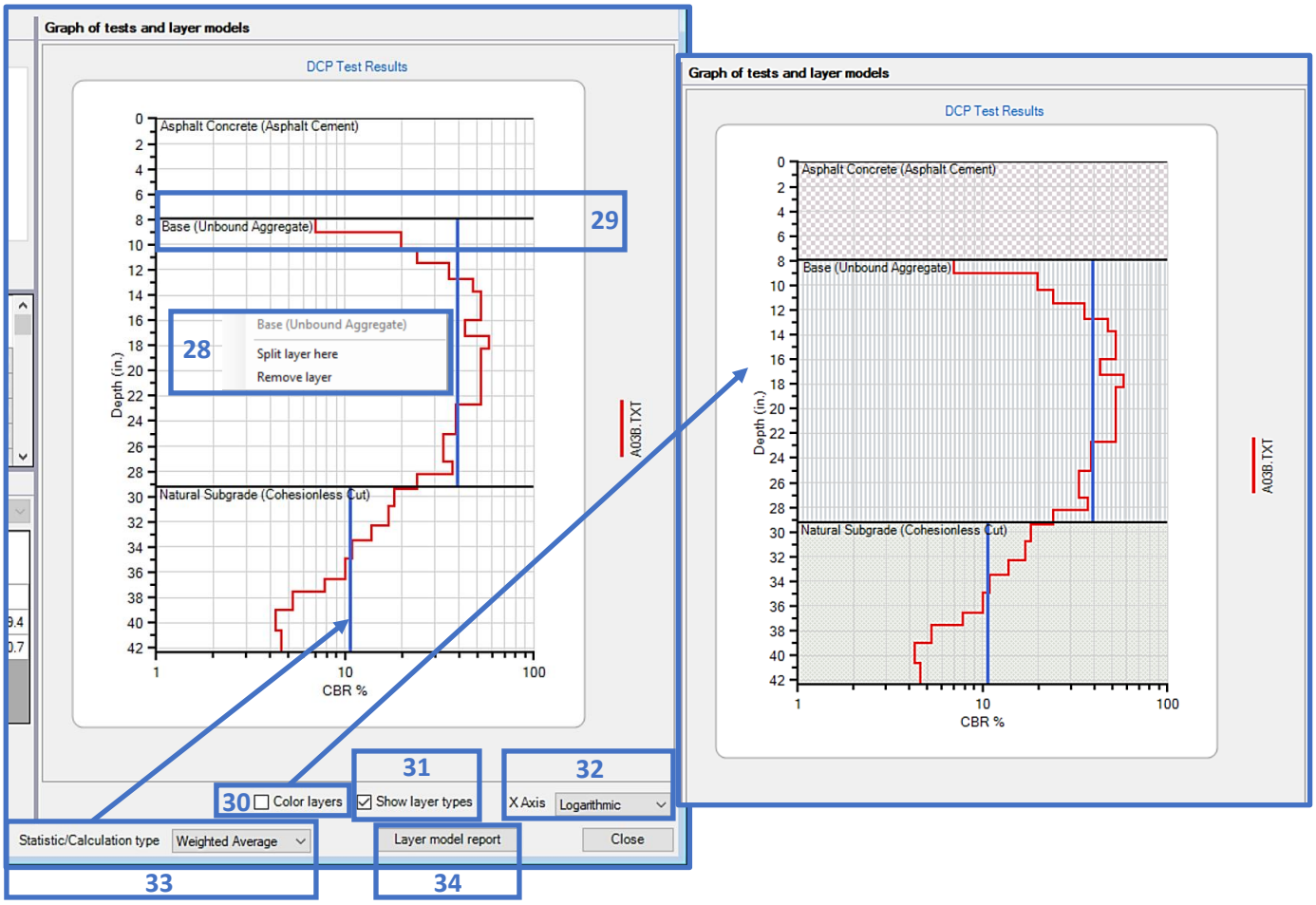


16.2.4 Graph of tests and layer models

As part of the DCP analysis; the Graph of tests and layer models chart can be used to graphically add and remove layer boundaries, or adjust the plotted Statistic/Calculation type values.

28. Right-click then select Split Layer here to add a layer boundary at that location of the plot. A layer boundary can also be removed; right-click, then select Remove Layer.
29. Each layer boundary can be adjusted within the chart by left-clicking on the layer boundary and dragging the cursor up or down to the desired value.
30. Turn on the Color layers feature to add a more distinct visual indication of layer separation.
31. Show layer types is turned on by default. Uncheck the checkbox to hide the layer type names.
32. Select between Linear or Logarithmic display options for the chart's X-Axis.
33. The selected Statistic/Calculation type values can also be adjusted within the chart by selecting and dragging a blue line in the chart to the desired value. Value changes made on the chart will automatically be reflected in the appropriate layer model grid column.

34. Layer model report outputs a layer model summary report. The DCP Data report (test data summary) is available for selection within the PCASE Reports window.



16.3 DCP Examples

16.3.1 Importing a DCP File and Performing Analysis

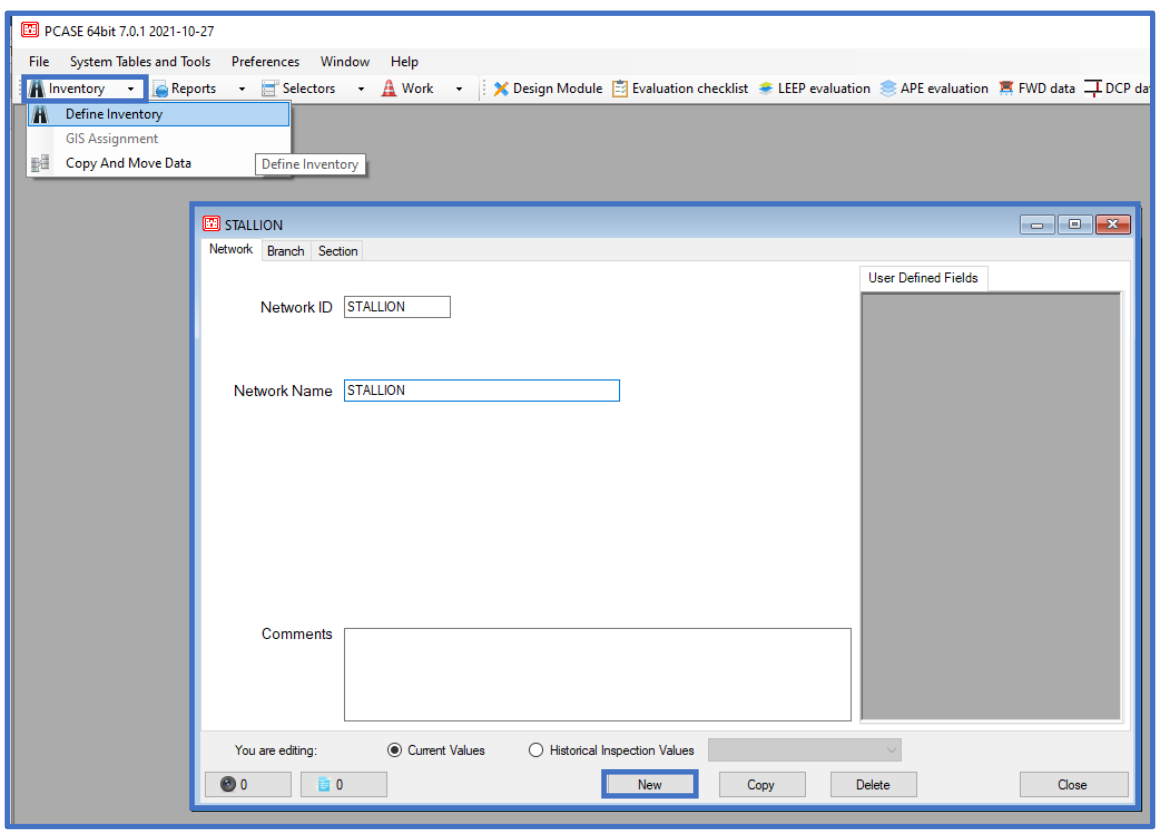
Process the DCP penetration data using the following analysis conditions:

- Network: Stallion, Branch: HP1, Section: A03B (Flexible)
- Import the DCP test file
- Evaluation Type: APE, CBR
- Hammer type: 17.6-lb hammer
- Soil type: mostly non-cohesive soil
- Ruler Starting Depth: 8-in.
- Surface Course Thickness: 8-in.
- Apply "Auto-break" layers function as the first step towards assigning layers
- Label and color the layers in the DCP Test Results plot

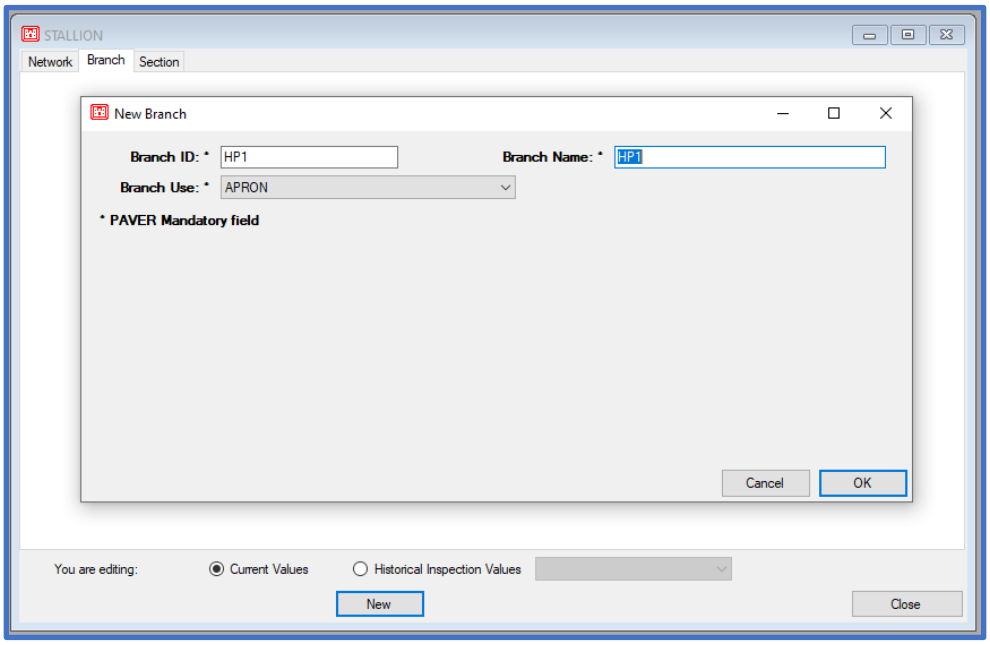
Stallion AAF, HP1, Section A03B

Step 1. Define the Inventory

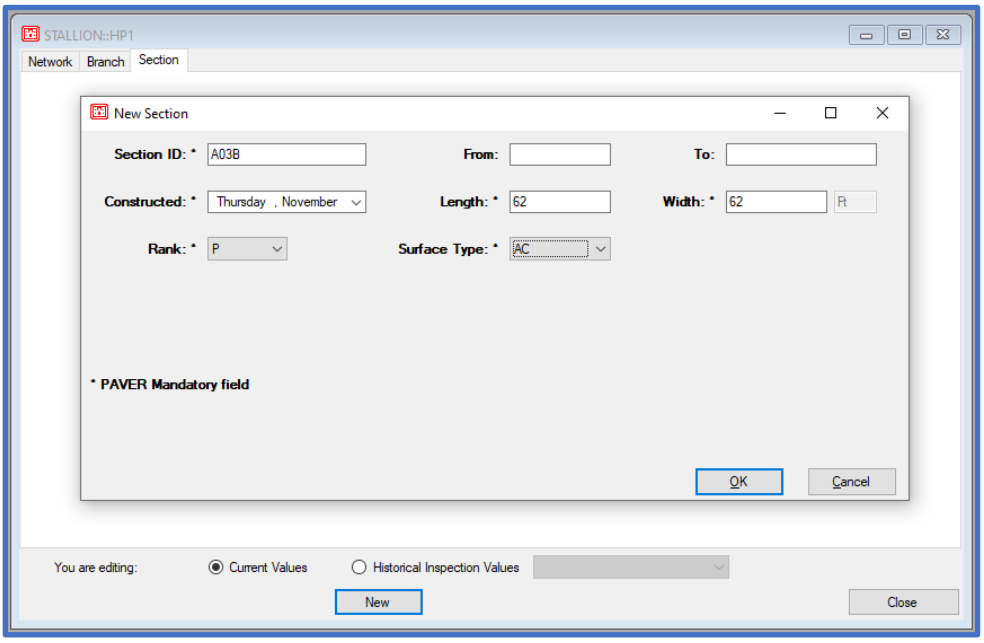
- Use the Inventory pulldown and select Define Inventory
- Select New on the Network tab, and define the Network



- Select the Branch tab, select New, and define the Branch

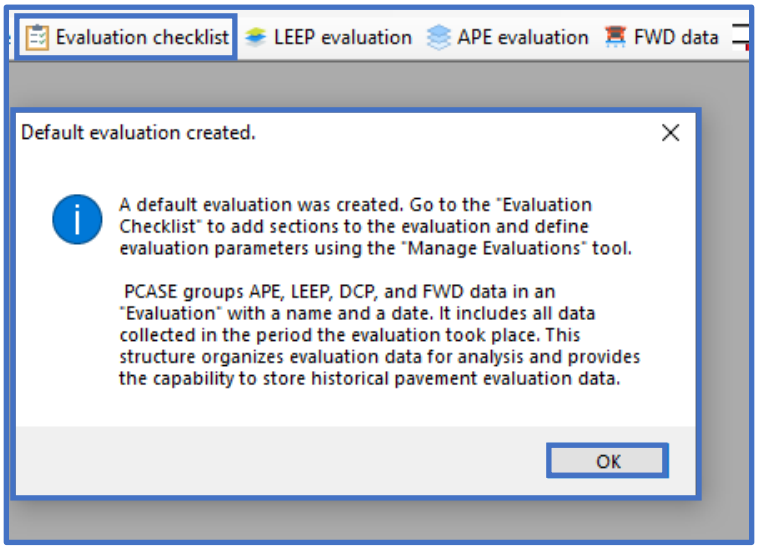


- Select the Section tab, select New, and define the Section

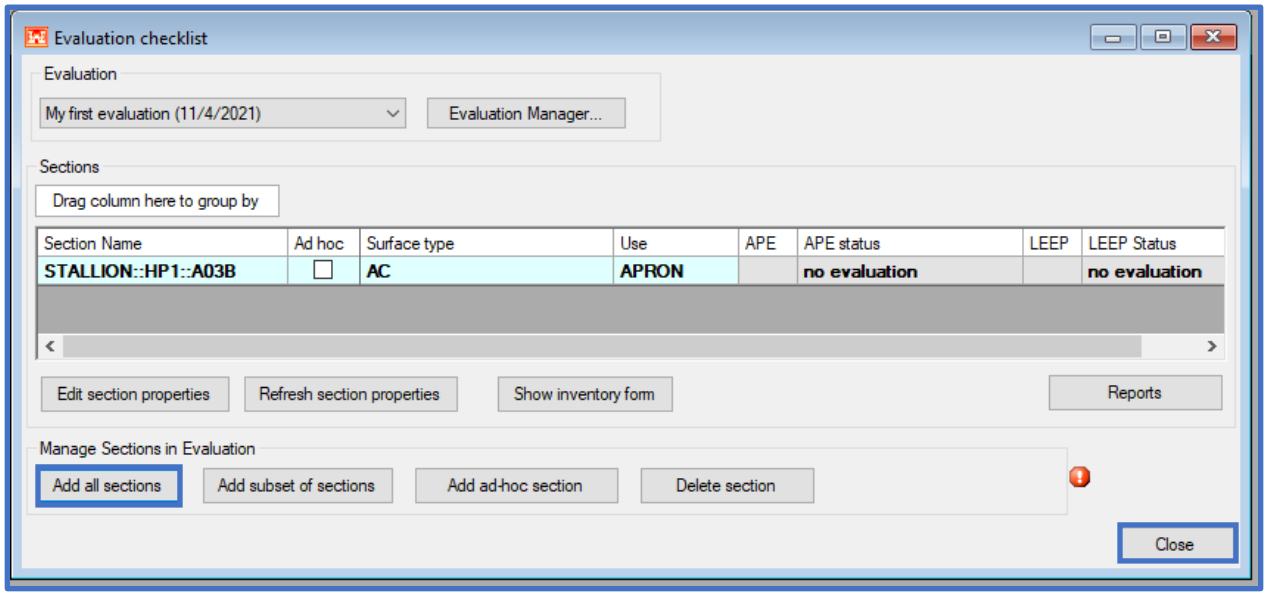


Step 2. Add the created section to the Evaluation Checklist form

- After processing the DCP data, APE evaluation will be used to analyze the section; but first, set up the section in Evaluation Checklist. Select Evaluation Checklist. A prompt will be initiated indicating that a default evaluation was created. Select OK.



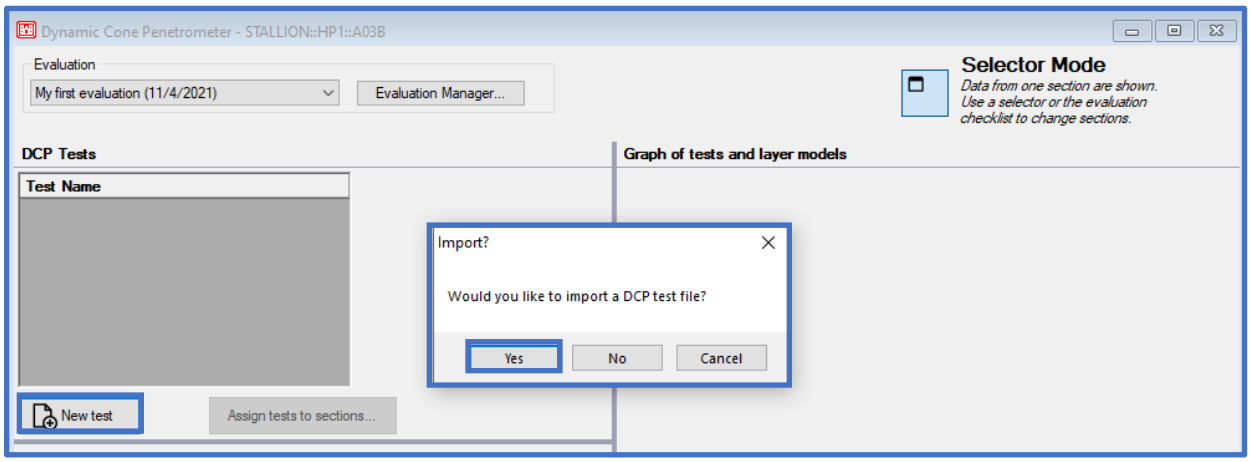
- Select Add all sections in the Evaluation Checklist form to declare an APE analysis. Next, select Close.



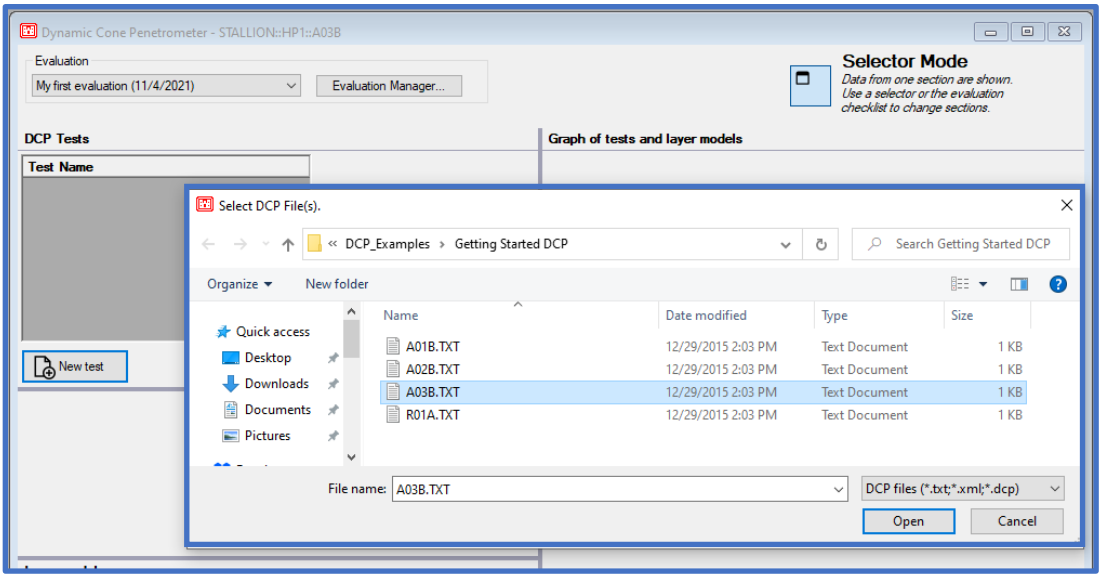
Step 3. Make selections within the DCP data form

- Select DCP data on the desktop to open the DCP data form

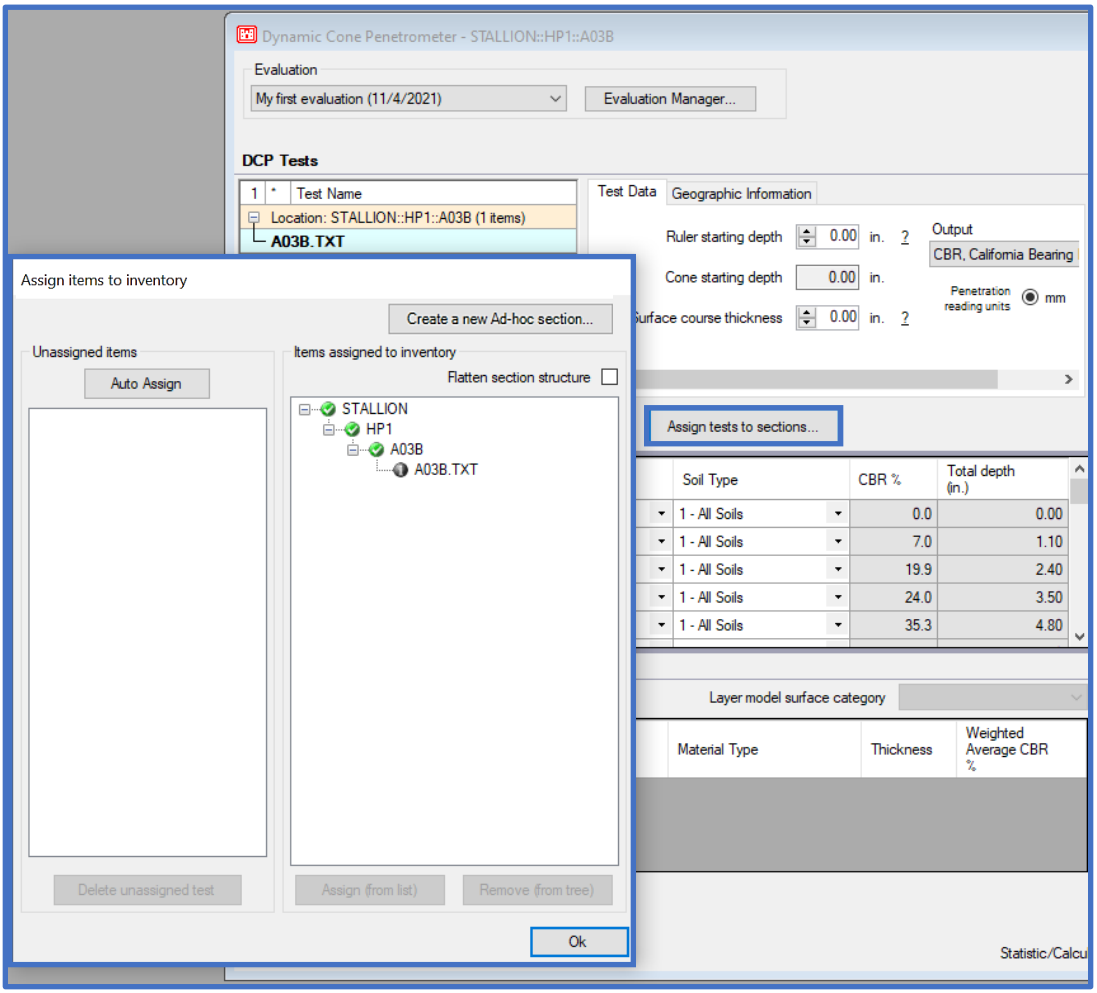
- Select New Test on the DCP data form
- The prompt will ask if a DCP test file is to be imported. For this example, select Yes to import a DCP test file.



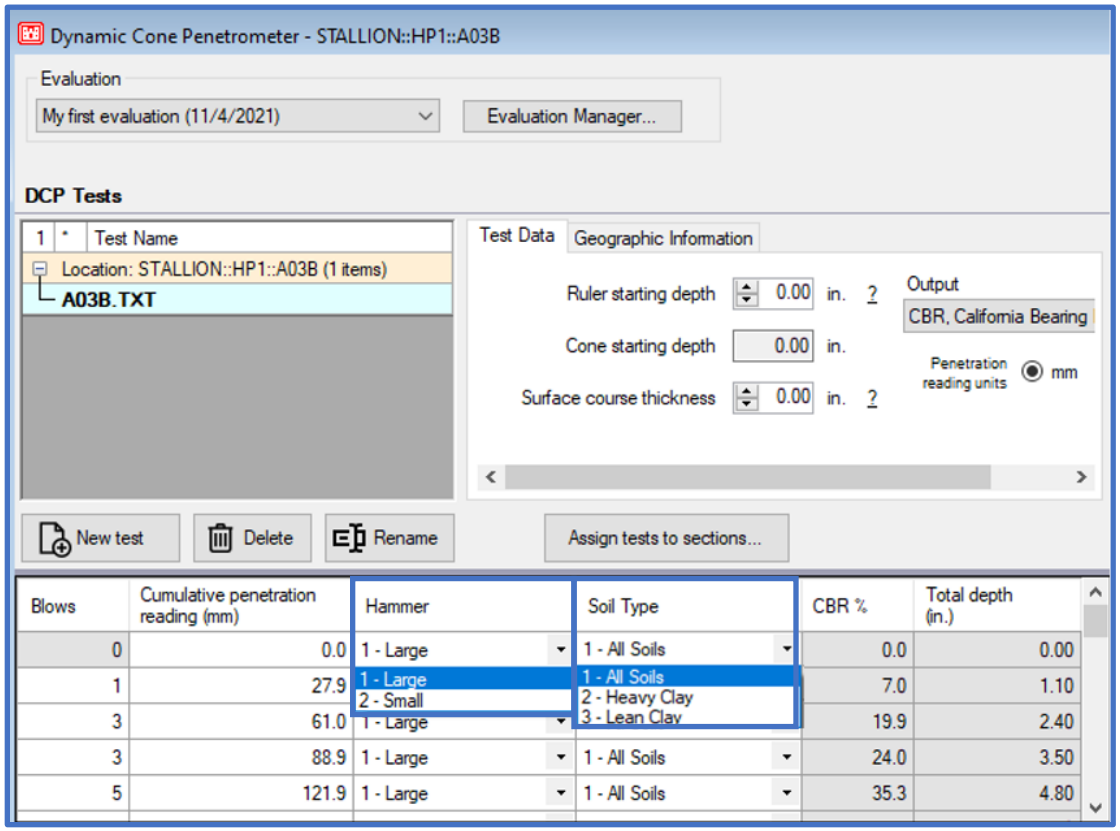
- Navigate to the applicable directory, select the A03B.TXT DCP data file, and select Open

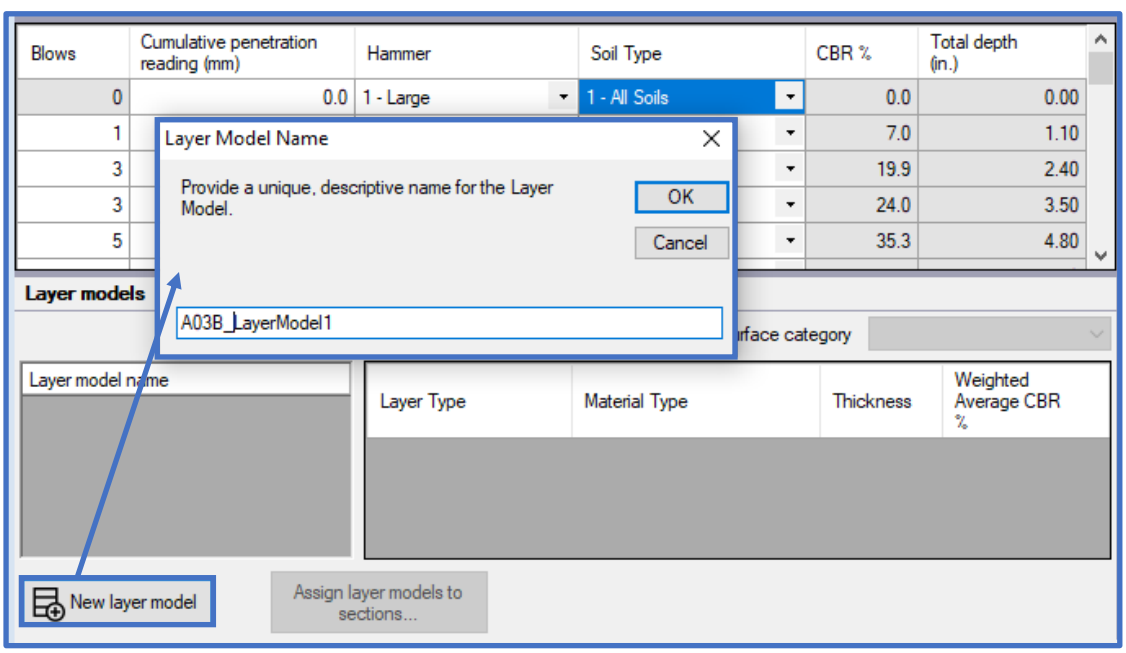


- The DCP data file will be automatically assigned to the inventory section of focus of the Selector tool. Select Assign tests to sections.... to display the assignment of the .TXT file to the associated inventory section in the Assign items to inventory form.

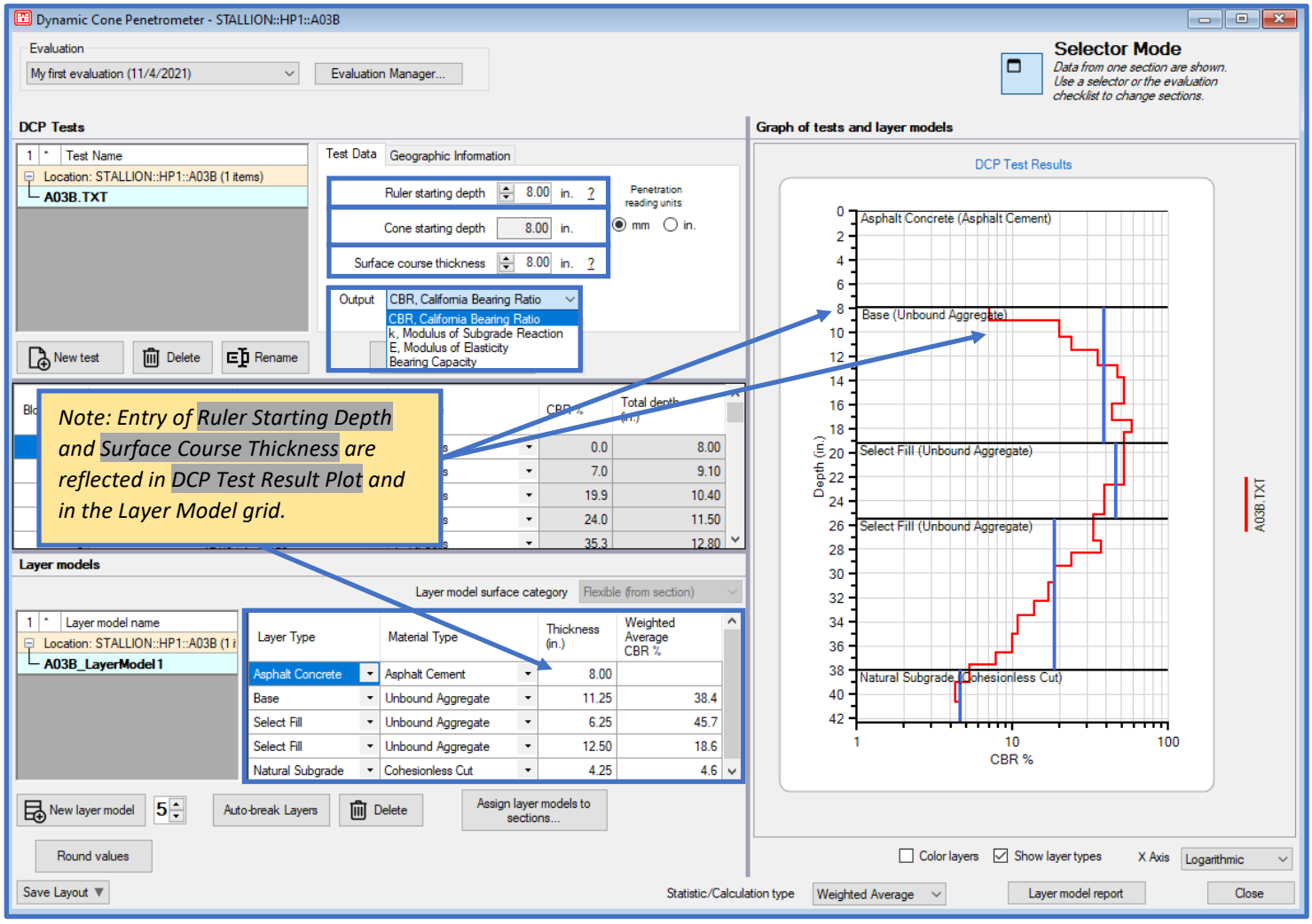


- For this example, select the following correlations to be applied for all the DCP penetration readings:
  - Hammer: 1-Large
  - Soil Type: 1-All Soils
- A Layer Model will be created (prior to identifying layers). Select New Layer Model on the DCP data form and enter a unique name.


Dynamic Cone Penetrometer - STALLION::HP1::A03B
Evaluation
My first evaluation (11/4/2021)
Evaluation Manager...
DCP Tests
Test Name
Location: STALLION::HP1::A03B (1 items)
A03B.TXT
Test Data
Geographic Information
Ruler starting depth
0.00
in.
Cone starting depth
0.00
in.
Surface course thickness
0.00
in.
Output
CBR, California Bearing
Penetration reading units
mm
New test
Delete
Rename
Assign tests to sections...
Blows
Cumulative penetration reading (mm)
Hammer
Soil Type
CBR %
Total depth (in.)
1 - Large
1 - All Soils
2 - Small
2 - Heavy Clay
3 - Lean Clay

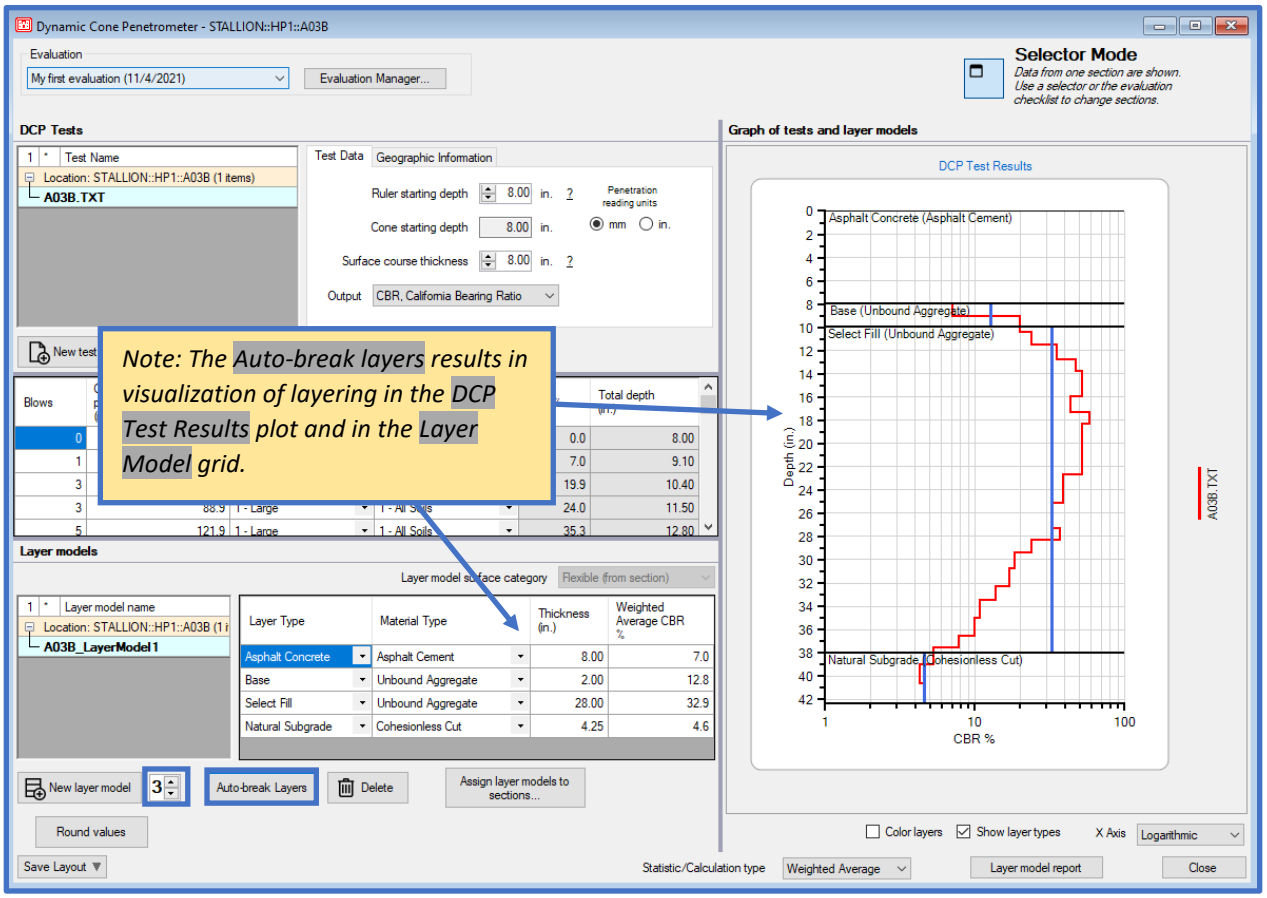

Blows
Cumulative penetration reading (mm)
Hammer
Soil Type
CBR %
Total depth (in.)
Layer Model Name
Provide a unique, descriptive name for the Layer Model.
OK
Cancel
A03B_LayerModel1
Layer models
Layer model name
Layer Type
Material Type
Thickness
Weighted Average CBR %
New layer model
Assign layer models to sections...

- On the Test Data tab enter:
  - Ruler starting depth: 8-in.
  - Surface course thickness: 8-in.
  - Output: CBR, California Bearing Ratio
- *Note: These selections are visualized in the DCP Test Results plot, as well as the Layer Model grid*

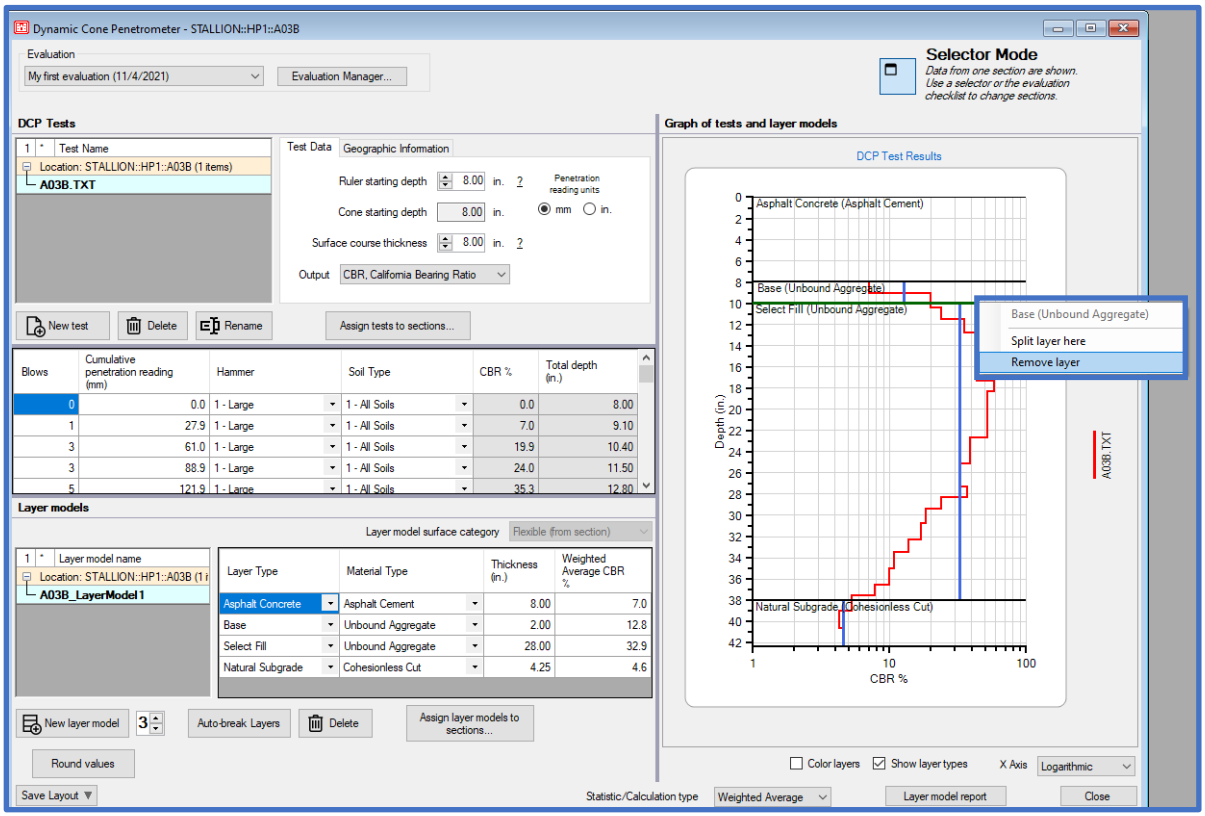


Step 4. Apply the Auto-break layer functionality as an initial mode of distinguishing the Layers

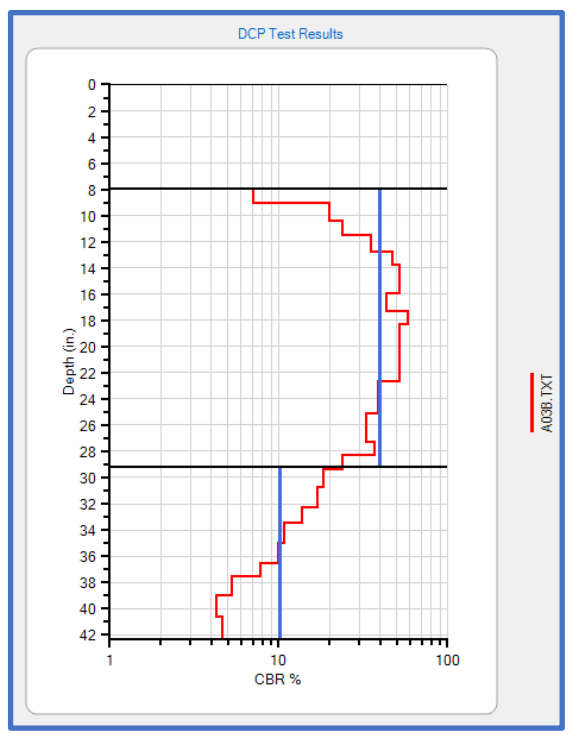
- Enter or scroll to the target layer count using the quantity field that is adjacent to the Auto-break Layers function
- Select Auto-break Layers to initialize the operation



- Next, remove the third layer interface by right-clicking on the layer interface and select Remove layer

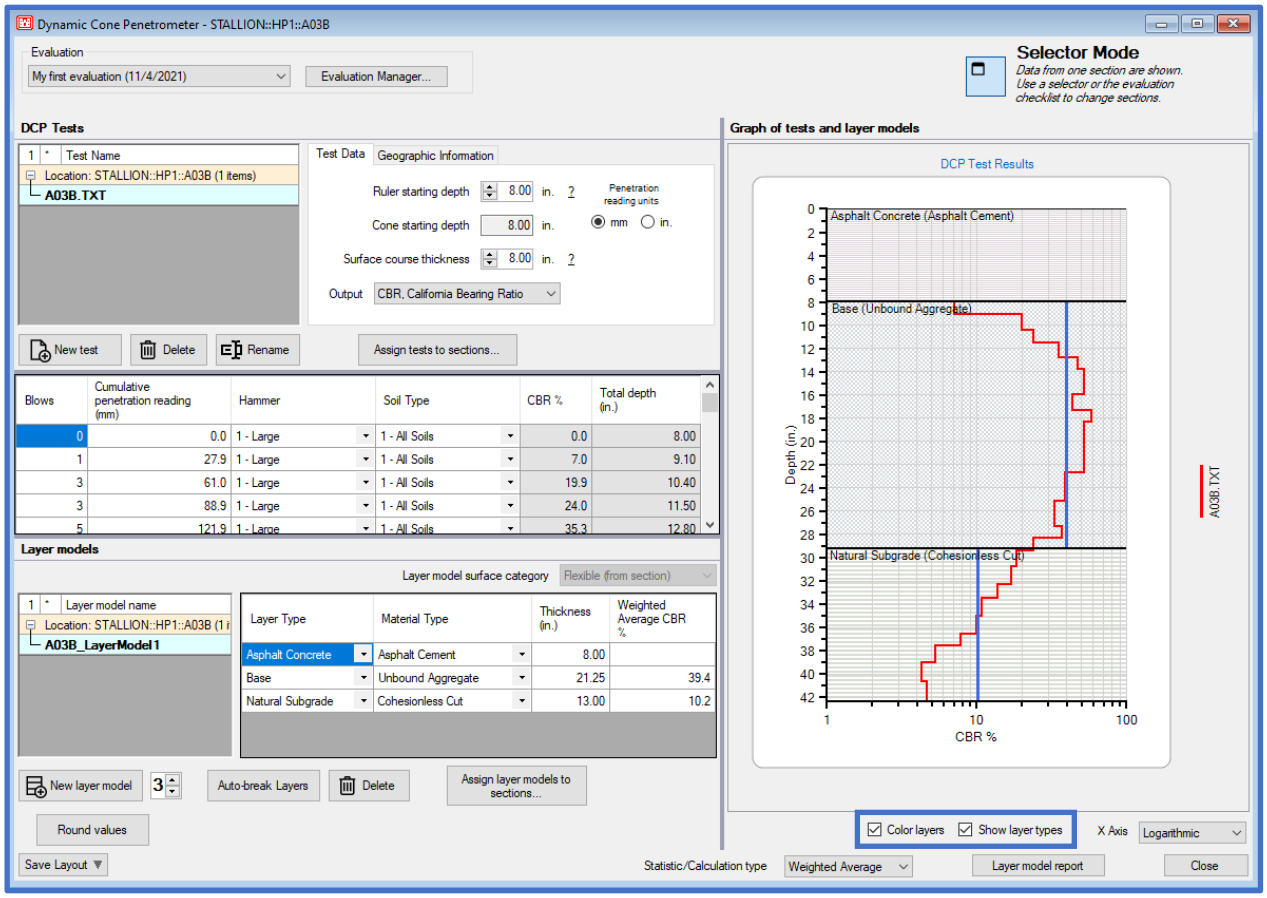


- The resultant layer structure:



Step 5. Label and color the layers in the DCP test result plot

- Select the Show layer types option
- Select the Color layers option to hatch fill or color the layers



16.3.2 Manual Data Entry of DCP Data and Performing Analysis

Process the DCP penetration data using the following analysis conditions:

- Network: Stallion, Branch: PAMAIN, Section: A01B (Flexible)
- Perform manual data entry of the DCP penetration readings shown in table 16.1
- Evaluation Type: LEEP
- Hammer type: 17.6-lb hammer
- Soil type: mostly non-cohesive soil
- Ruler Starting Depth: 6-in.
- Surface Course Thickness: 6-in.
- Apply Auto-break Layers function as the first step towards assigning layers
- X Axis: toggle between Linear and Logarithmic
- Compare Statistic/Calculation Type: Weighted Average and Average
- Manually adjust the Weighted Average Statistic/Calculation Type on the DCP Test Results Plot

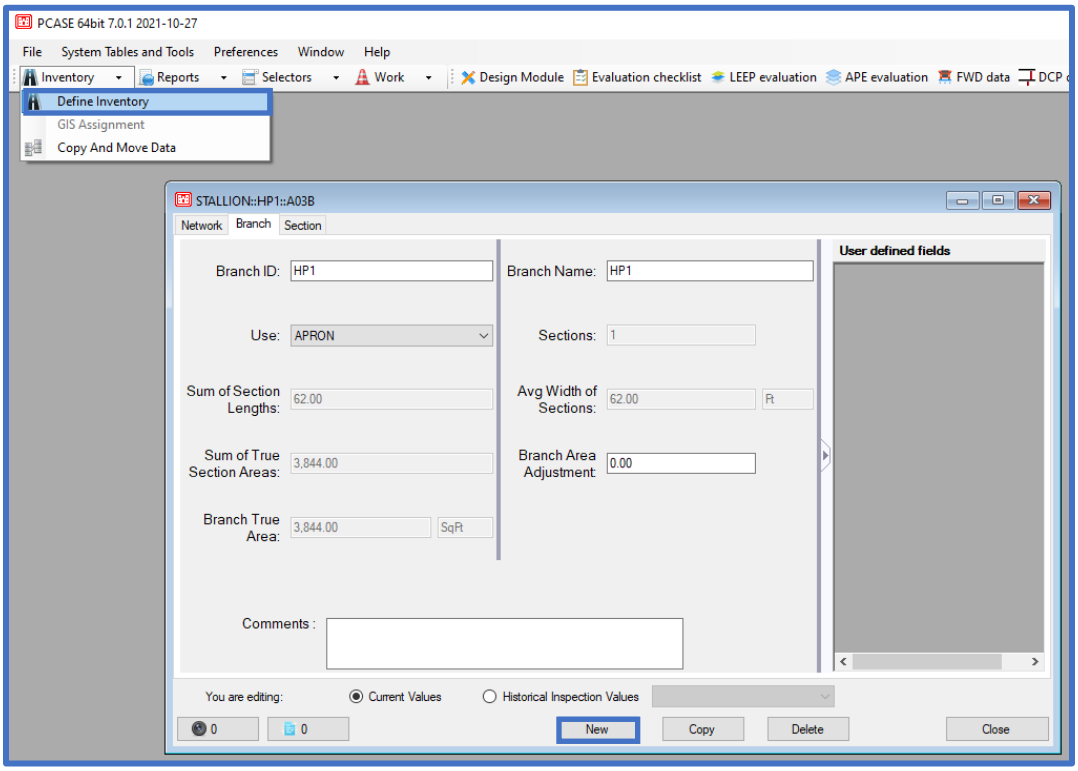
Table 13.1- Stallion AAF: PAMAIN: A01B, DCP Readings

Blows	Cumulative Penetration (in.)
0	0.0
2	1.4
3	2.6
4	3.8
5	4.8
6	5.9
6	6.9
6	8.0
6	9.0
7	10.1
7	11.2
6	12.4
6	13.4
6	14.6
5	15.6
5	16.9
4	18.0
4	19.0
4	20.2
3	21.4
3	22.8
3	24.3
2	25.3
2	26.5
2	27.9
2	29.5
2	31.4
2	33.5

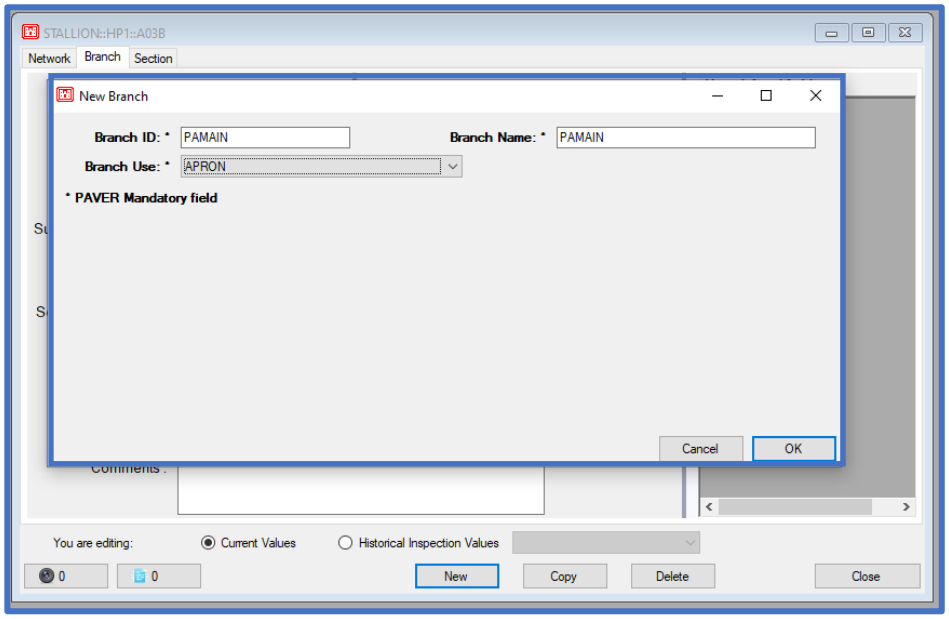
Stallion AAF; PAMAIN, Section A01B

Step 1. Define the Inventory

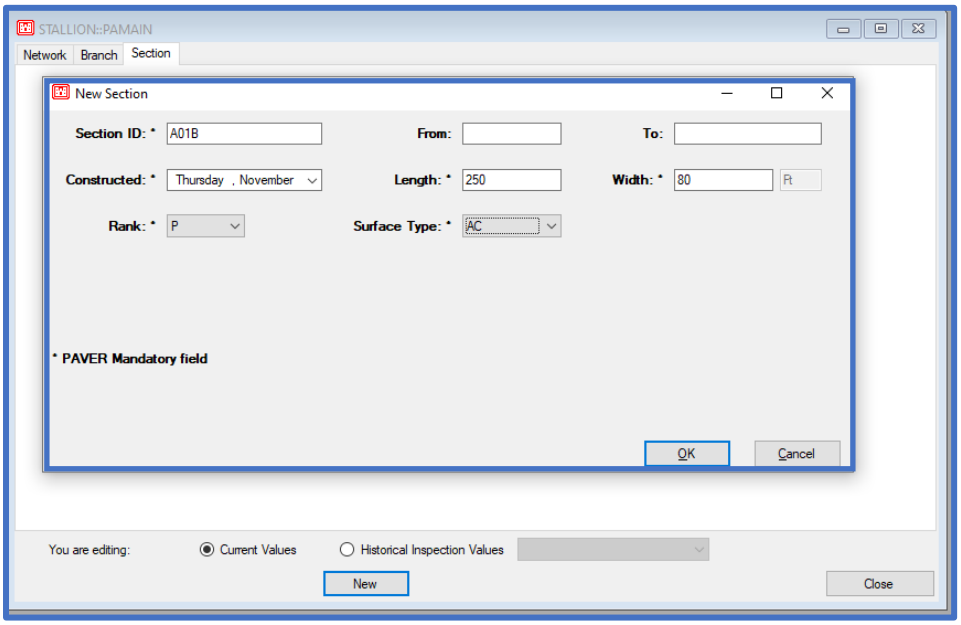
- Use the Inventory pulldown and select Define Inventory
- This example is a continuation of Stallion AAF; the network is already defined
- Select New on the Branch tab



- Select the Branch tab, select New and define the Branch

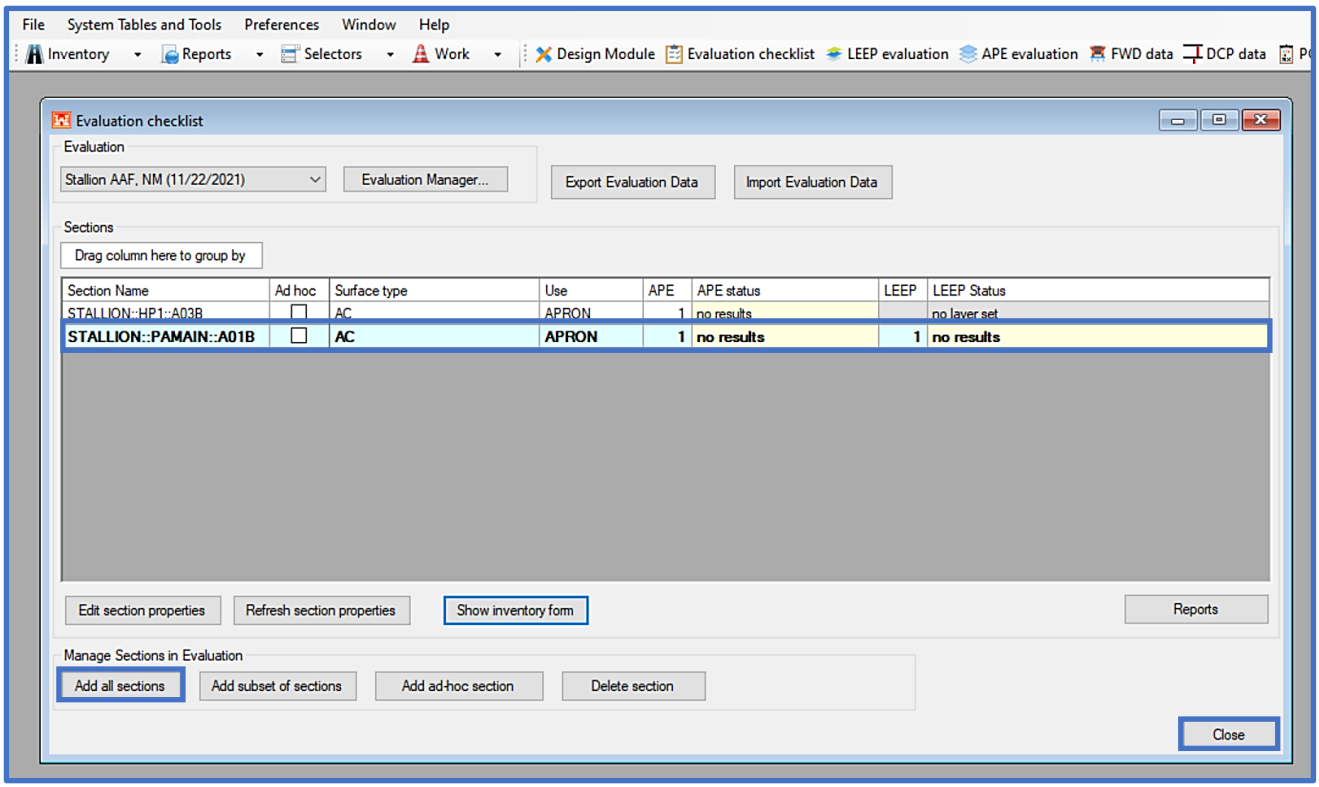


- Select the Branch tab, select New and define the Branch



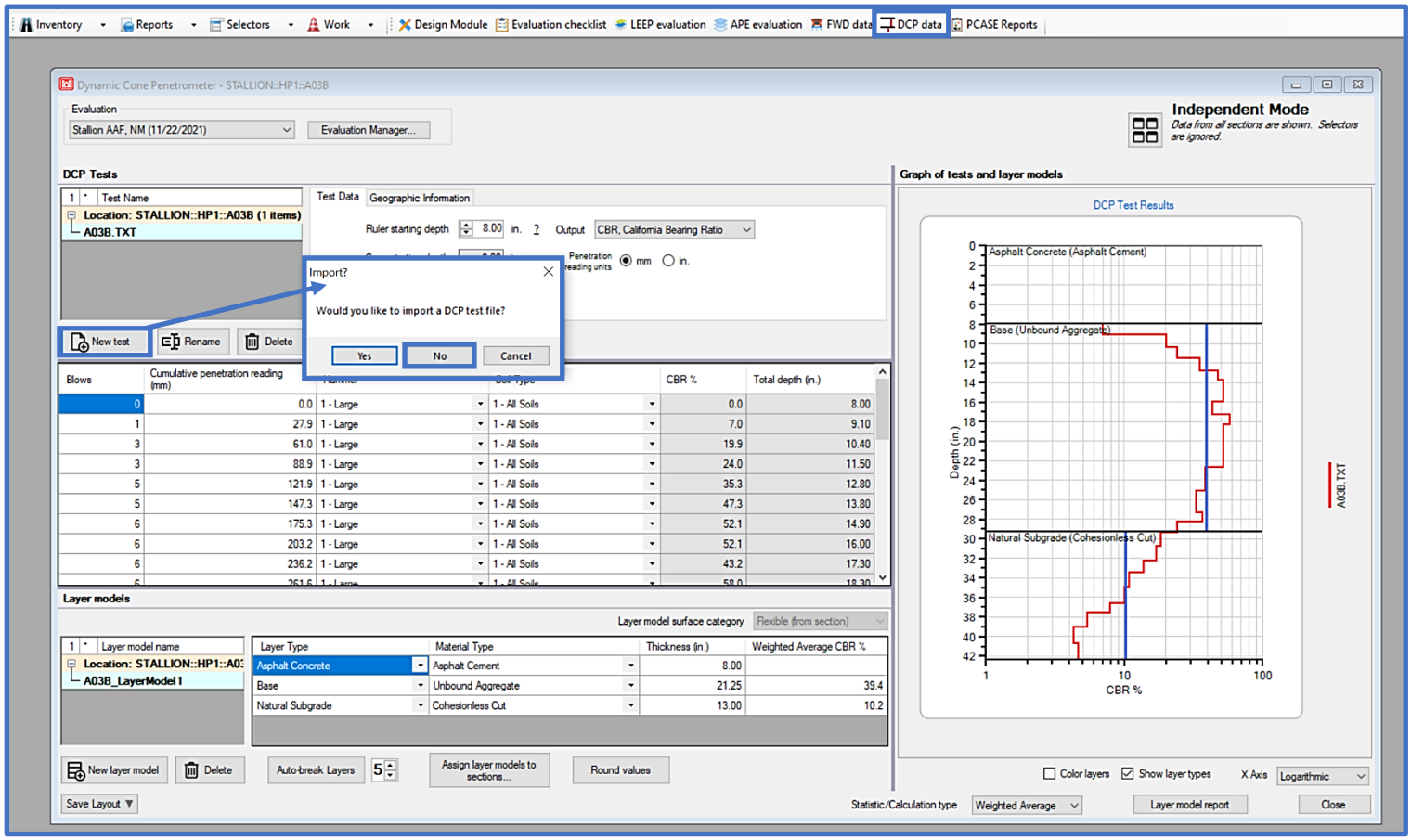
Step 2. Add created section within the Evaluation Checklist form

- After processing the DCP data, LEEP evaluation will be used to analyze the section; but first, set up the section in Evaluation Checklist. Select Evaluation Checklist.
- Select Add all sections in the Evaluation Checklist form to declare a LEEP analysis for this section. Next, select Close.

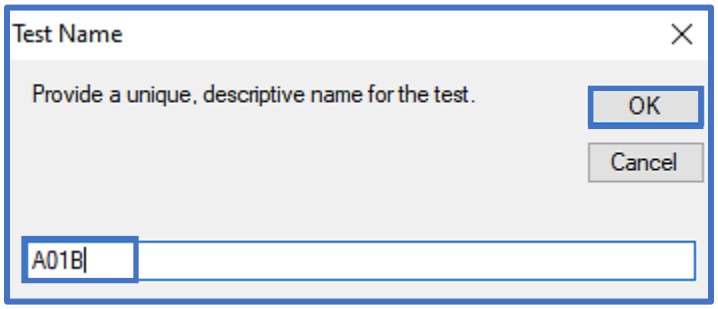


Step 3. Make selections within the DCP data form

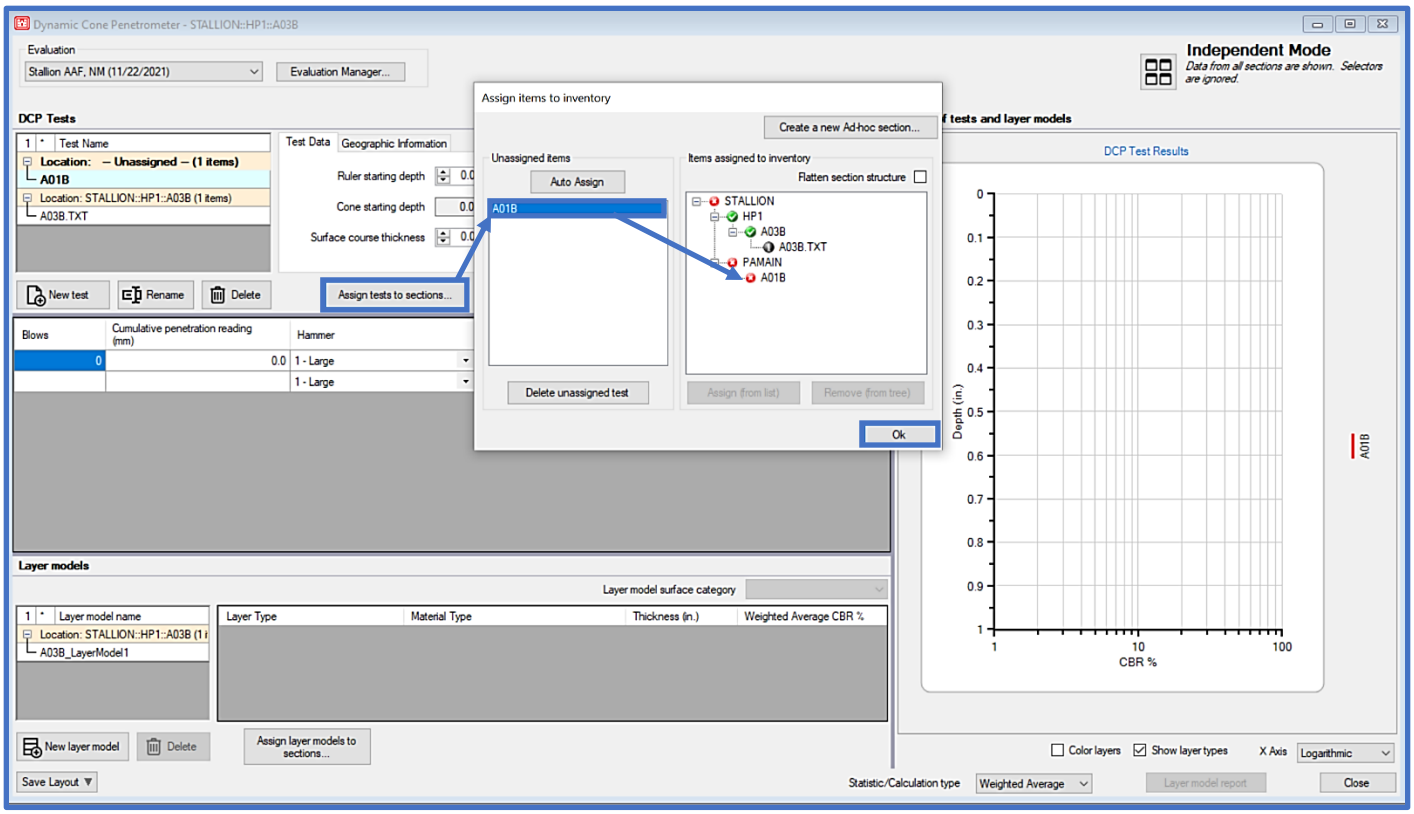
- Select DCP data on the desktop to open the DCP data form
- Since this example occurs within the same inventory as the previous DCP analysis, then the previous example DCP data will be shown. This will occur within pavement inventories where there is existing data.
- To create a new DCP analysis, select New test
- The prompt will ask if a DCP test file is to be imported. For this example, select No; the DCP data will be entered manual.



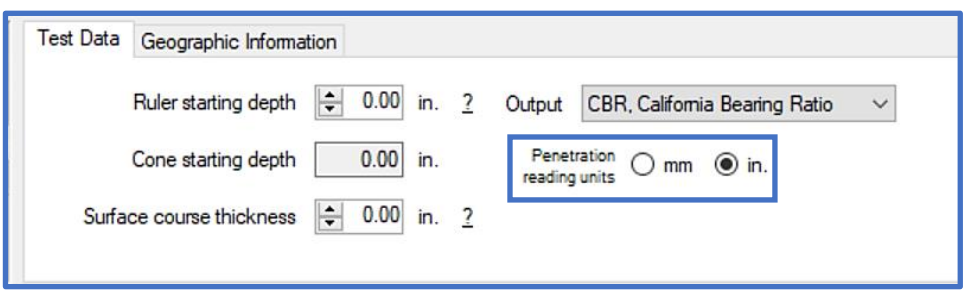
- Enter a unique name for the DCP test and select OK



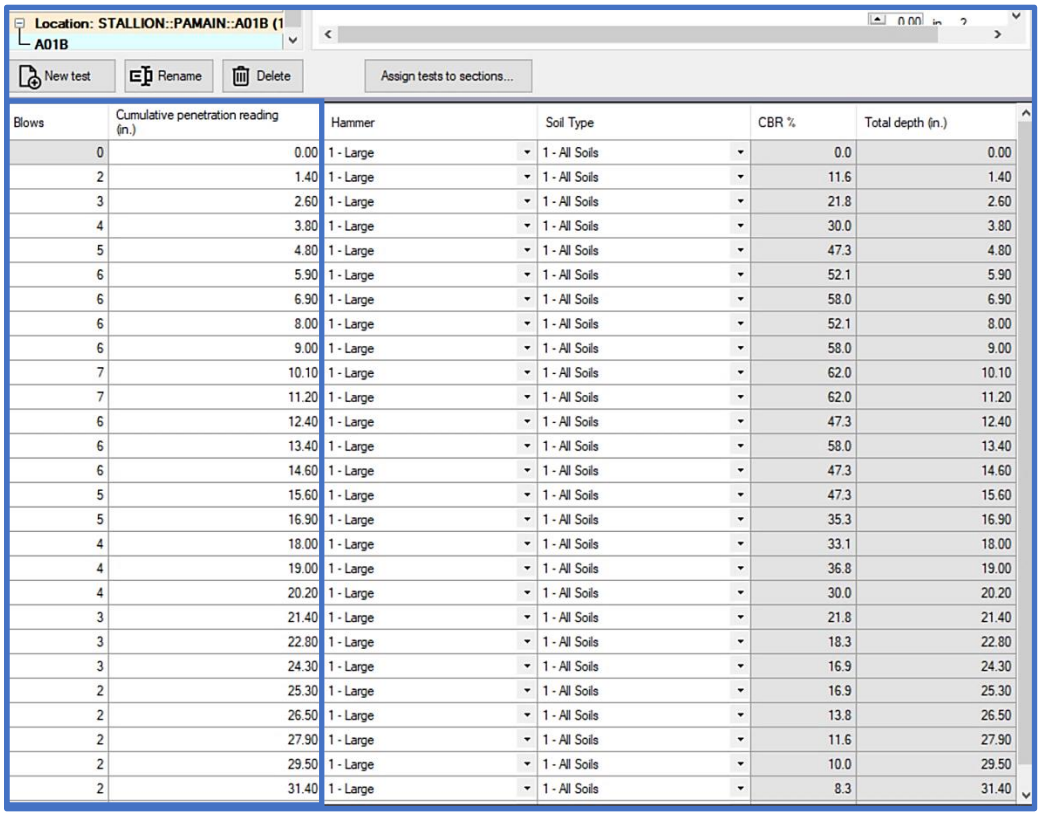
- A blank DCP form is produced for user data entry and parameter selection. Assign the test to the appropriate Section by selecting Assign tests to sections… then drag A01B to the appropriate Section and click Ok.



- Given the English units of measurement for the penetration readings, use the radio button under Penetration reading units and select in.

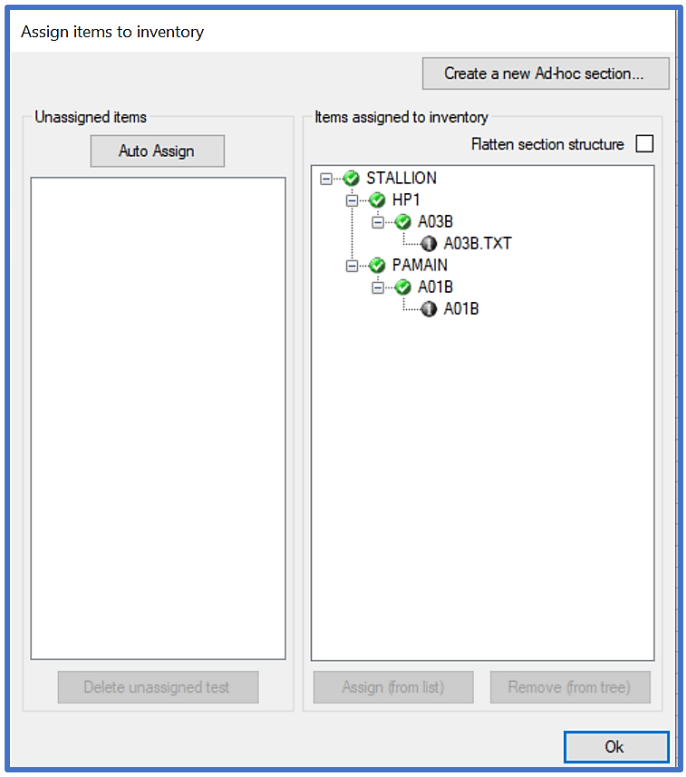


- Enter DCP data into the DCP readings penetration grid. To manually input DCP readings, select the second cell in the Blows column and enter a value. To input the associated Cumulative penetration reading value, you can either select the cell field with your cursor or press Tab on the keyboard to toggle to the next field. Once the Blows and Cumulative penetration reading values are entered for a row press, Enter or Tab on the keyboard to generate a new row.

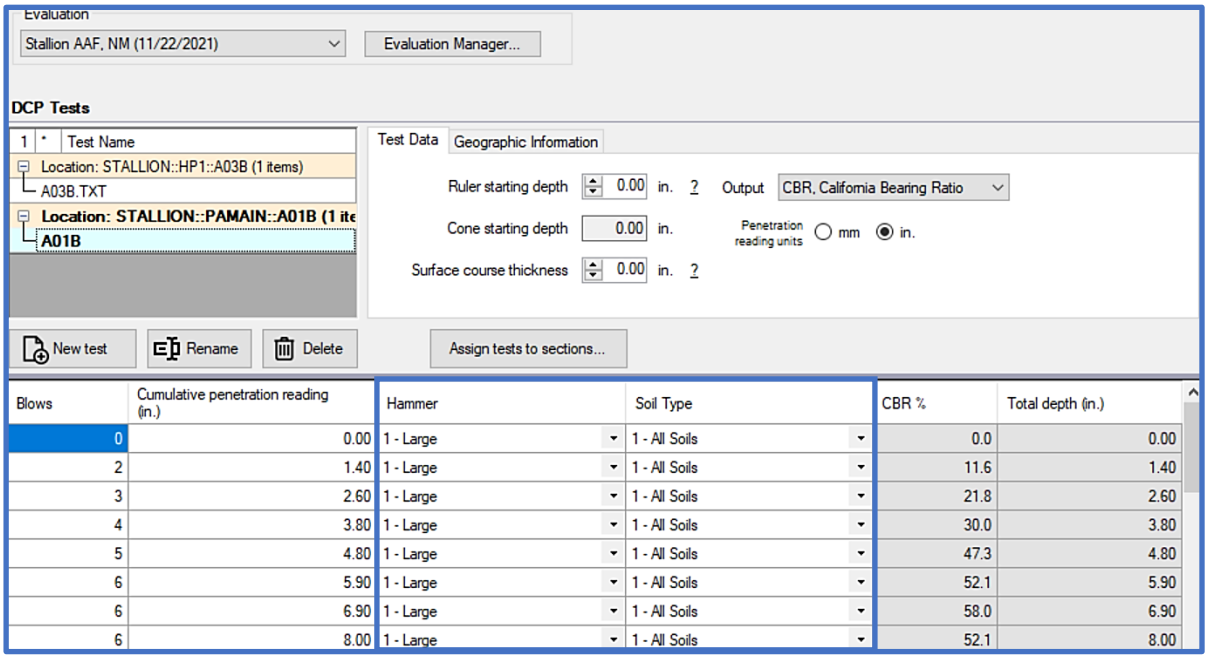


Blows	Cumulative penetration reading (in.)	Hammer	Soil Type	CBR %	Total depth (in.)
0	0.00	1 - Large	1 - All Soils	0.0	0.00
2	1.40	1 - Large	1 - All Soils	11.6	1.40
3	2.60	1 - Large	1 - All Soils	21.8	2.60
4	3.80	1 - Large	1 - All Soils	30.0	3.80
5	4.80	1 - Large	1 - All Soils	47.3	4.80
6	5.90	1 - Large	1 - All Soils	52.1	5.90
6	6.90	1 - Large	1 - All Soils	58.0	6.90
6	8.00	1 - Large	1 - All Soils	52.1	8.00
6	9.00	1 - Large	1 - All Soils	58.0	9.00
7	10.10	1 - Large	1 - All Soils	62.0	10.10
7	11.20	1 - Large	1 - All Soils	62.0	11.20
6	12.40	1 - Large	1 - All Soils	47.3	12.40
6	13.40	1 - Large	1 - All Soils	58.0	13.40
6	14.60	1 - Large	1 - All Soils	47.3	14.60
5	15.60	1 - Large	1 - All Soils	47.3	15.60
5	16.90	1 - Large	1 - All Soils	35.3	16.90
4	18.00	1 - Large	1 - All Soils	33.1	18.00
4	19.00	1 - Large	1 - All Soils	36.8	19.00
4	20.20	1 - Large	1 - All Soils	30.0	20.20
3	21.40	1 - Large	1 - All Soils	21.8	21.40
3	22.80	1 - Large	1 - All Soils	18.3	22.80
3	24.30	1 - Large	1 - All Soils	16.9	24.30
2	25.30	1 - Large	1 - All Soils	16.9	25.30
2	26.50	1 - Large	1 - All Soils	13.8	26.50
2	27.90	1 - Large	1 - All Soils	11.6	27.90
2	29.50	1 - Large	1 - All Soils	10.0	29.50
2	31.40	1 - Large	1 - All Soils	8.3	31.40

- Verify that the DCP data file was correctly assigned to the inventory Section by selecting Assign tests to sections... to display the assignment of the file to the associated inventory section in the Assign items to inventory form.

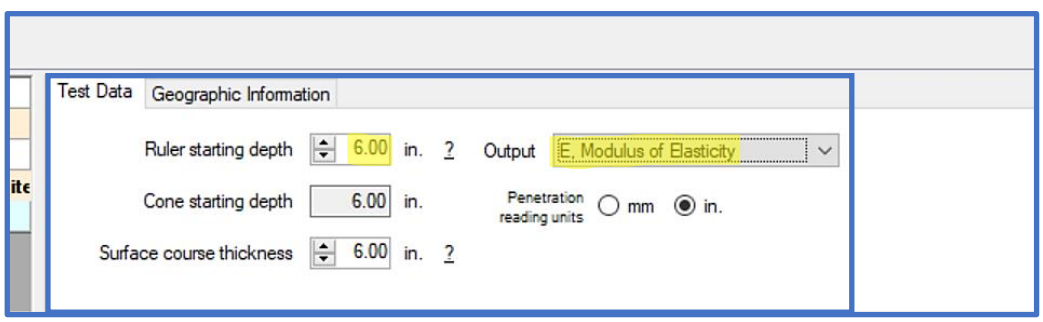


- For this example, verify the following correlations have been applied for all the DCP penetration readings:
  - Hammer: 1-Large
  - Soil Type: 1-All Soils
- A Layer Model will be created (prior to identifying layers). Select New Layer Model on the DCP data form and enter a unique name.

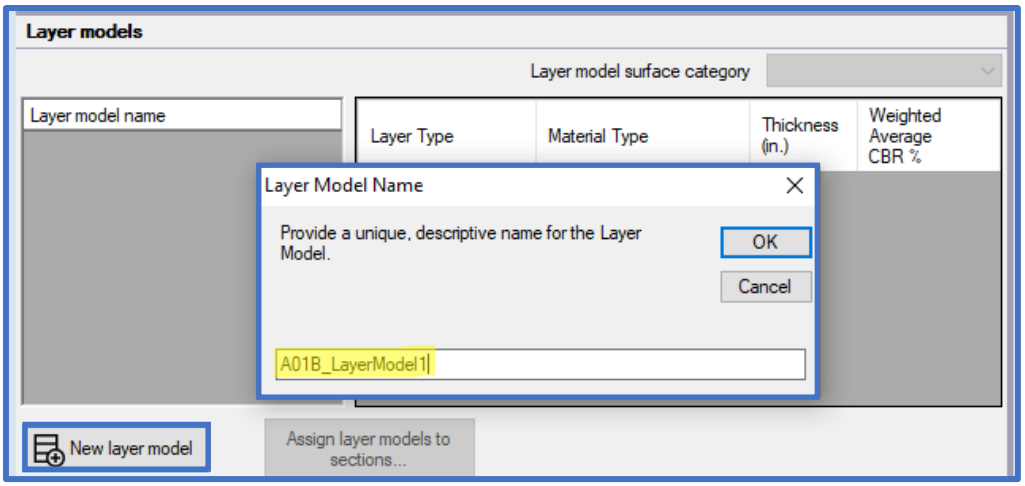


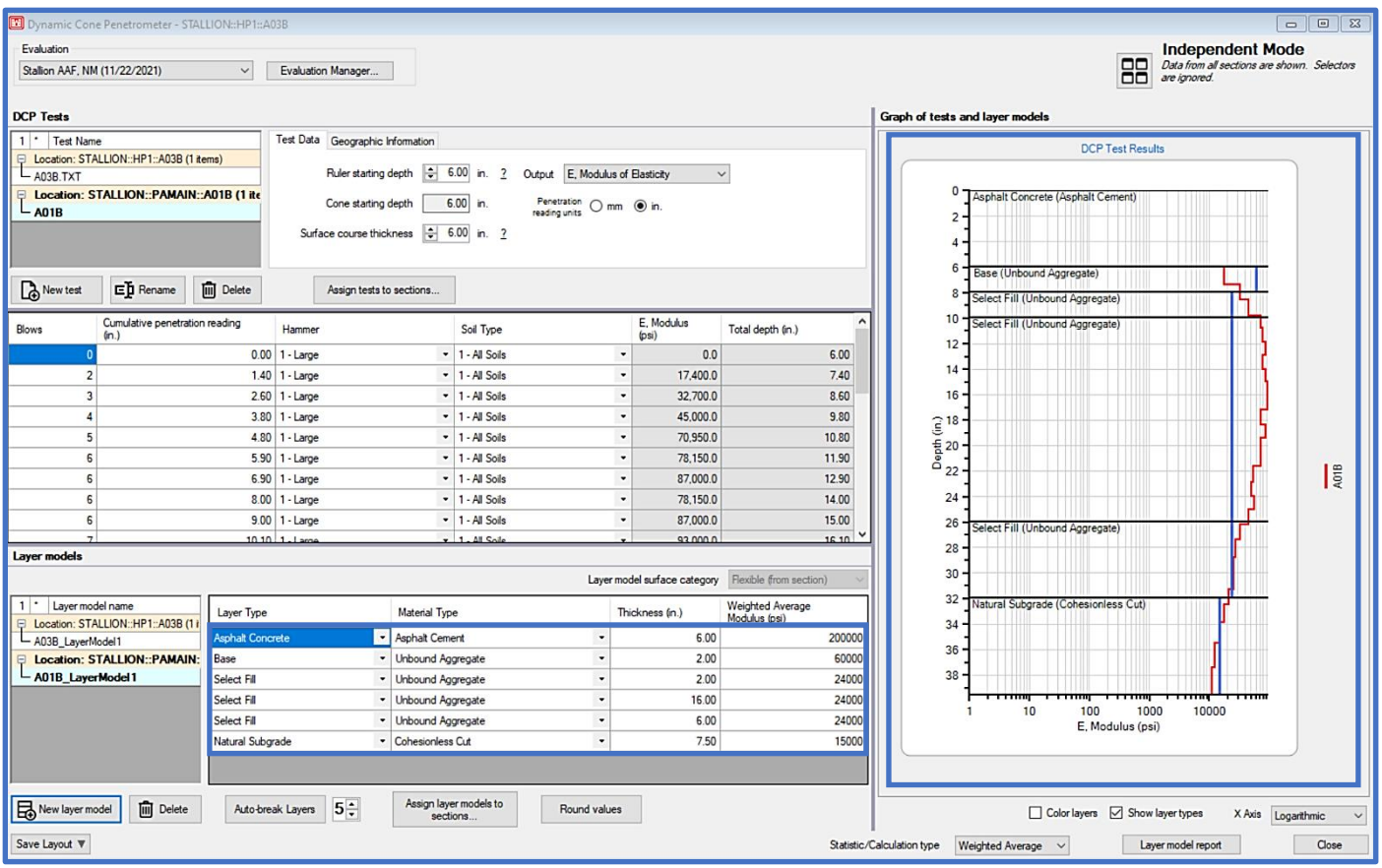
- On the Test Data tab enter:
  - Ruler starting depth: 6-in.
  - Surface course thickness (updates automatically according to Ruler starting depth): 6-in.
  - Output: E, Modulus of Elasticity

Note: These selections are visualized in the DCP Test Results plot, as well as the Layer Model grid.



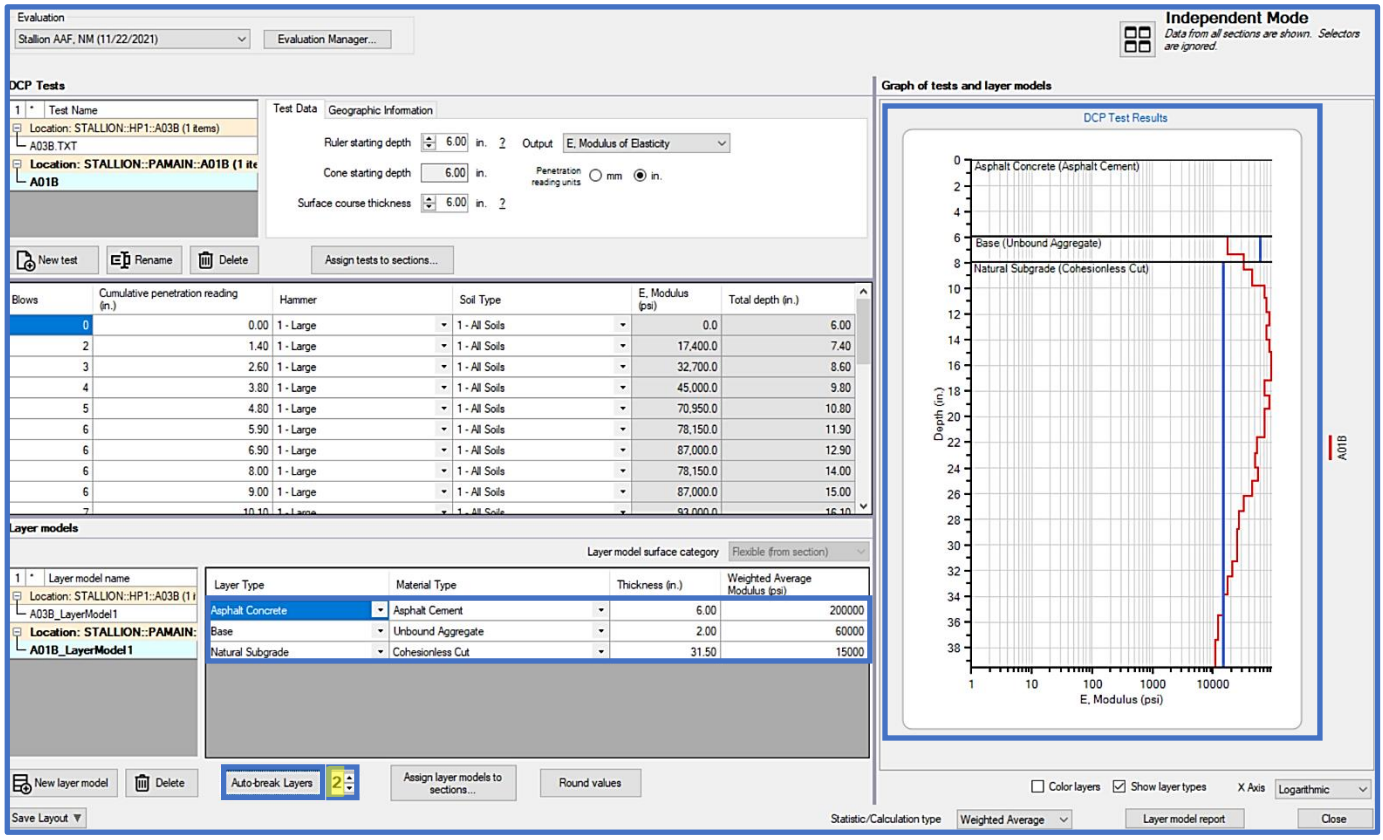
- A Layer Model will be created (prior to identifying layers). Select New Layer Model on the DCP data form and enter a unique name.





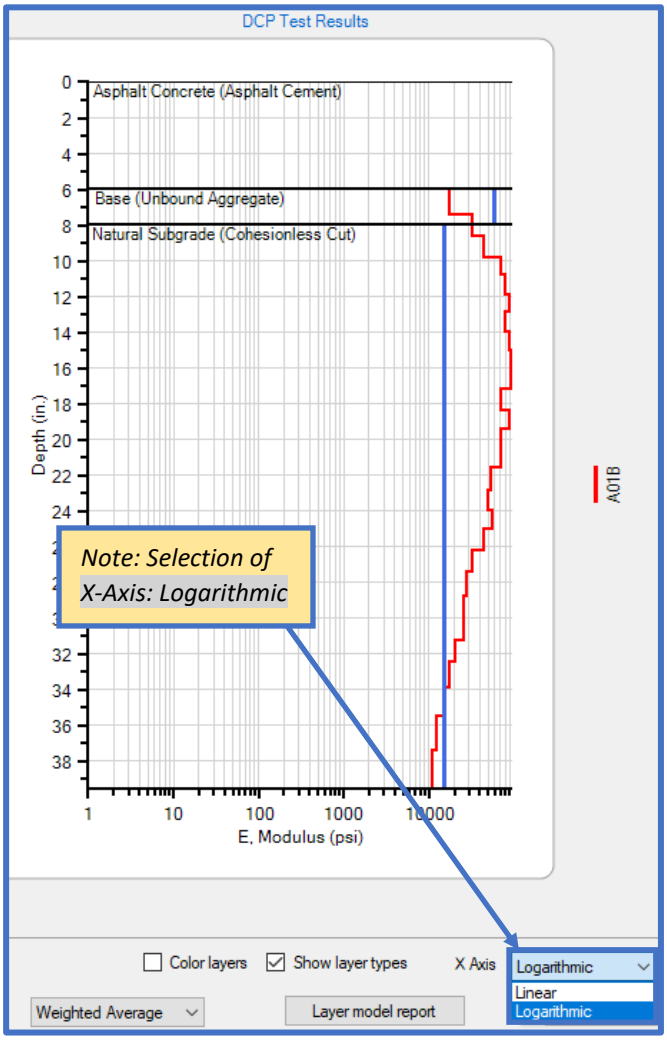
Step 4. Apply the Auto-break layer functionality as an initial mode of distinguishing the Layers

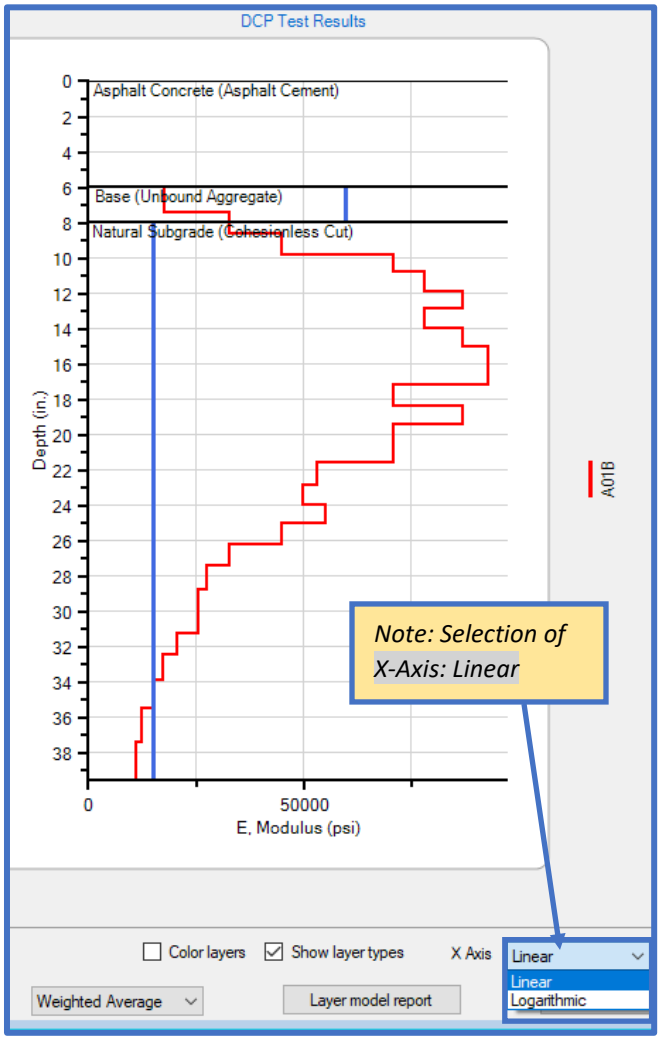
- Enter or scroll to the target layer count using the quantity field that is adjacent to the Auto-break Layers function
- Select Auto-break Layers to initialize the operation



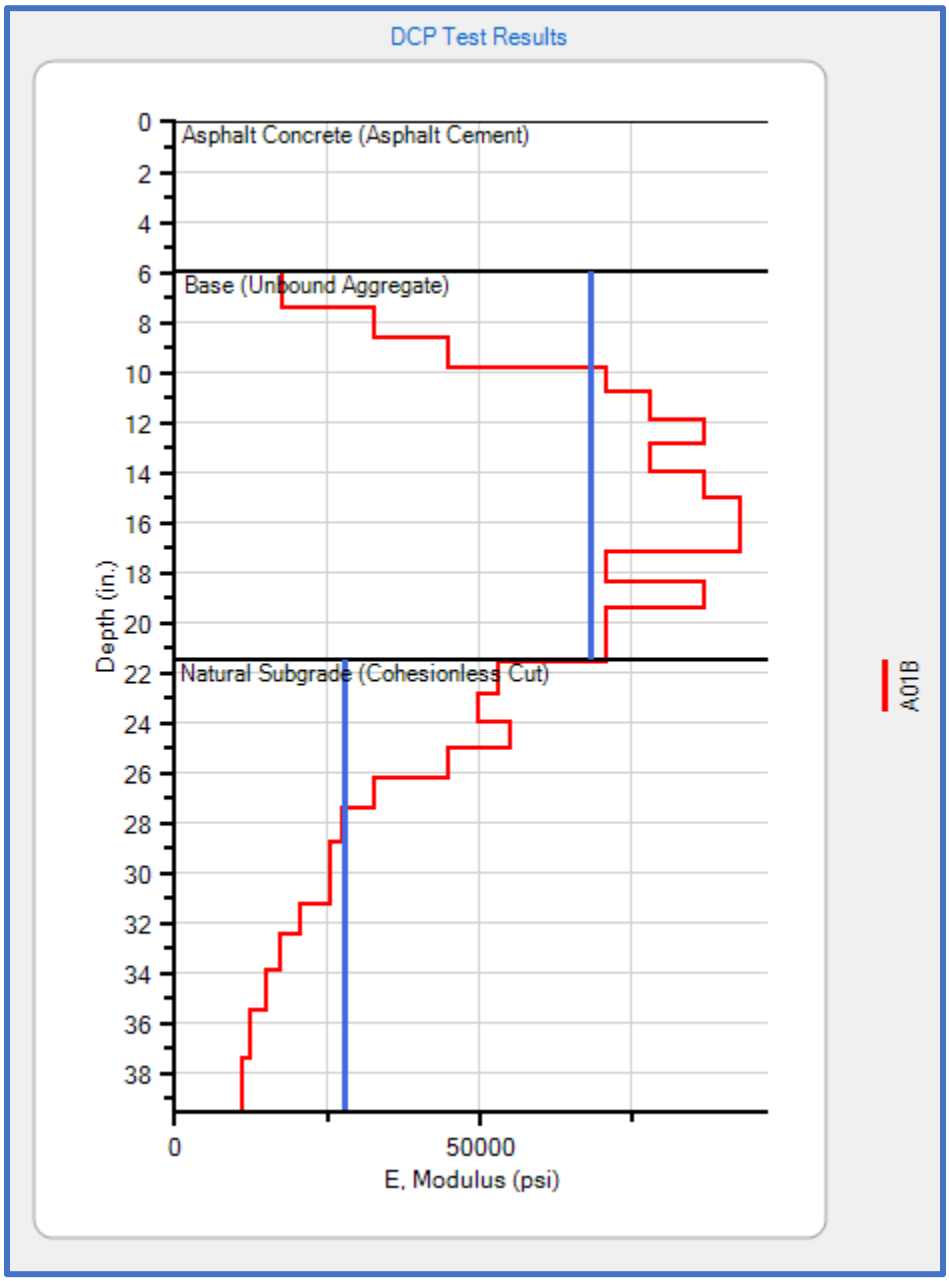
Step 5. X-Axis: Toggle between Logarithmic and Linear to view differences

- Select X-Axis: Logarithmic
- Select X-Axis: Linear
- Select X-Axis: Linear, for the remainder of this analysis





Step 6. Manually modify the layers to reflect the test results shown below.

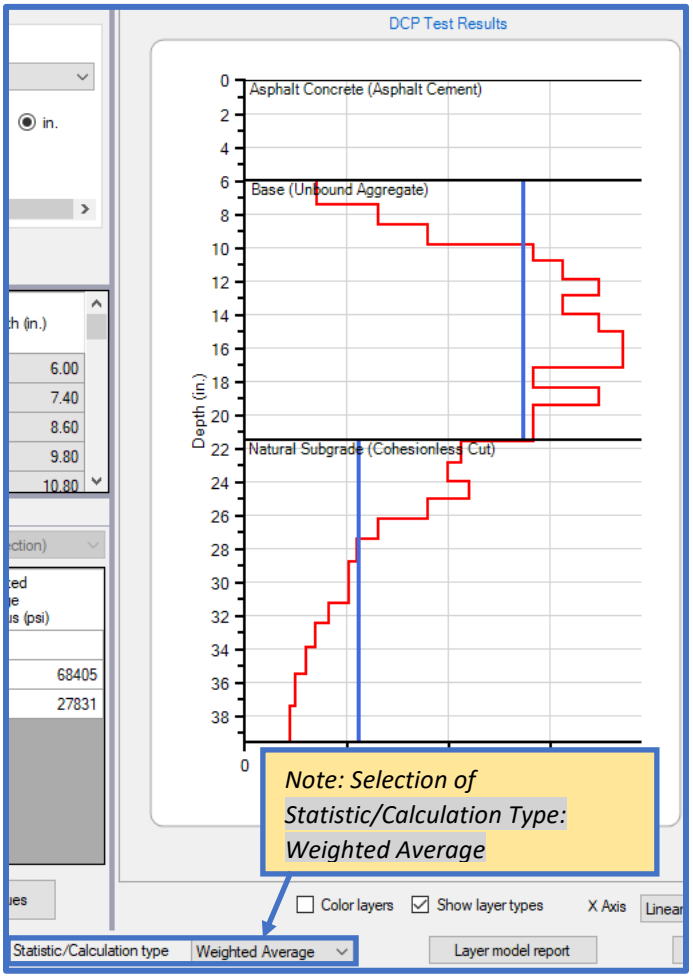


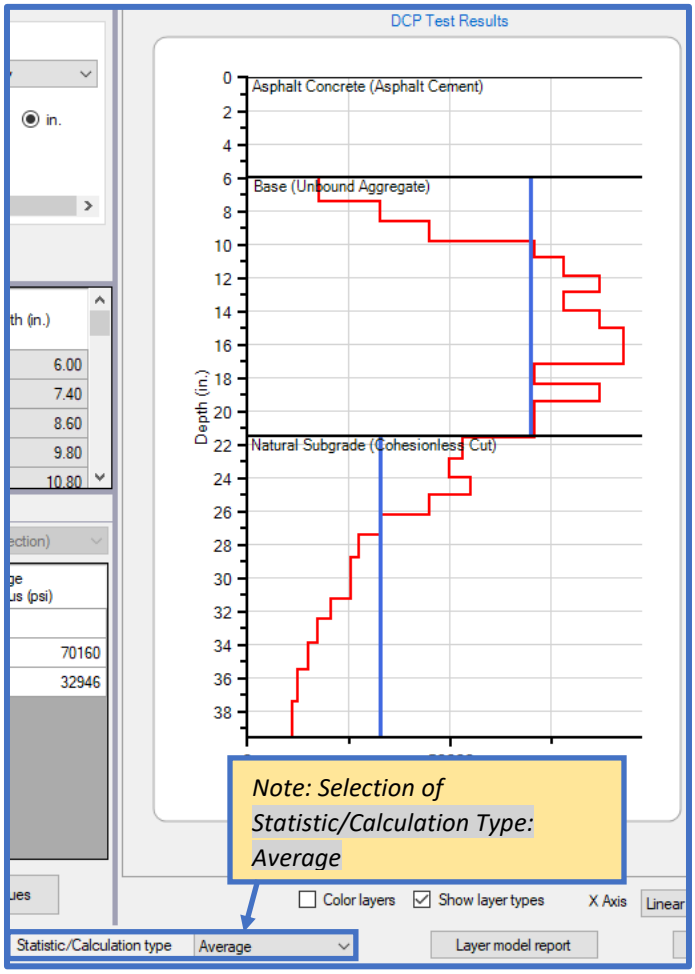
Layer model surface category: Flexible (from section)

Layer Type	Material Type	Thickness (in.)	Weighted Average Modulus (psi)
Asphalt Concrete	Asphalt Cement	6.00	
Base	Unbound Aggregate	15.50	68401
Natural Subgrade	Cohesionless Cut	18.00	27831

Step 7. Compare Statistic/Calculation type: Weighted Average and Average

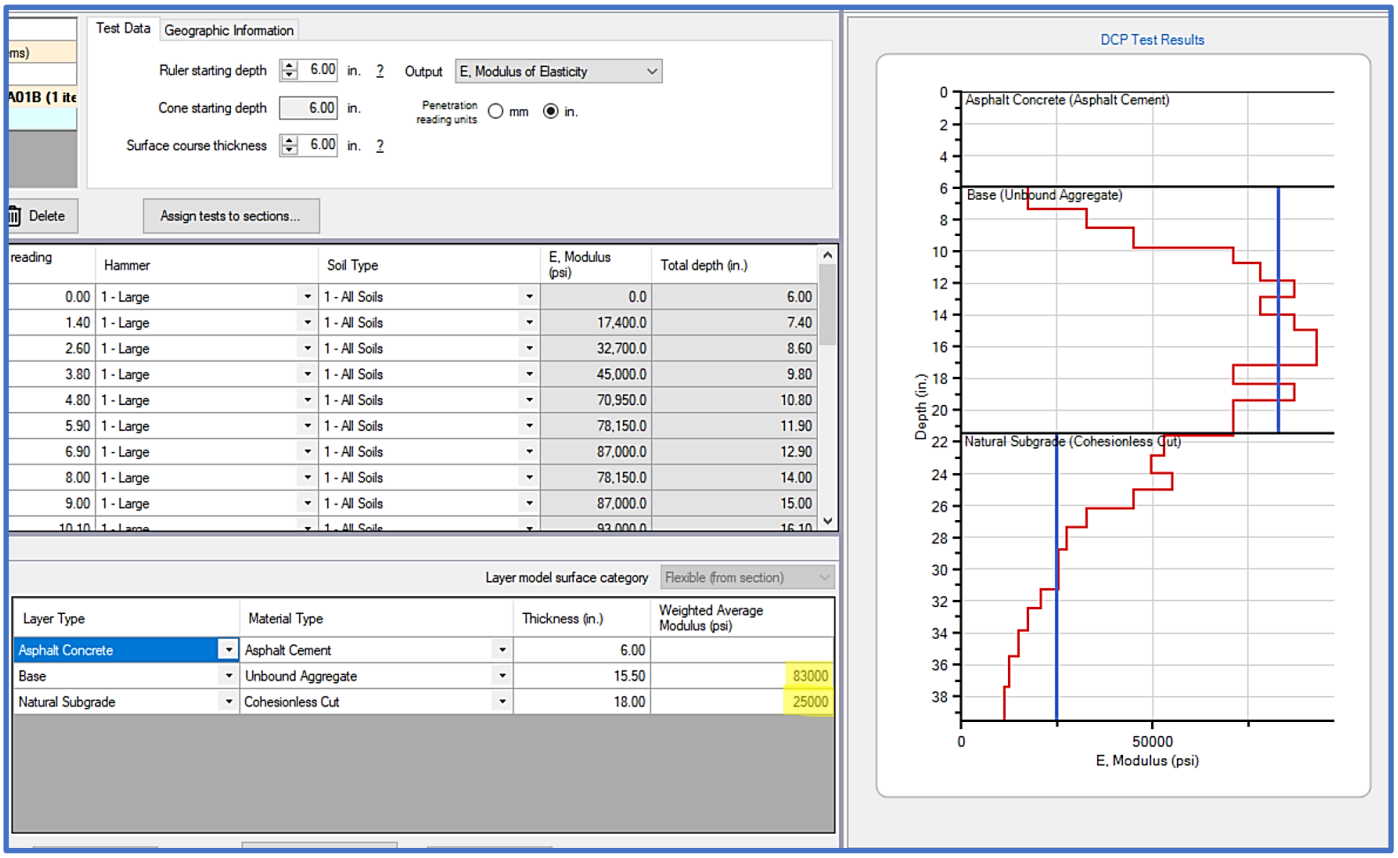
- Select Statistic/Calculation type: Weighted Average from the drop-list
- Select Statistic/Calculation type: Average from the drop-list





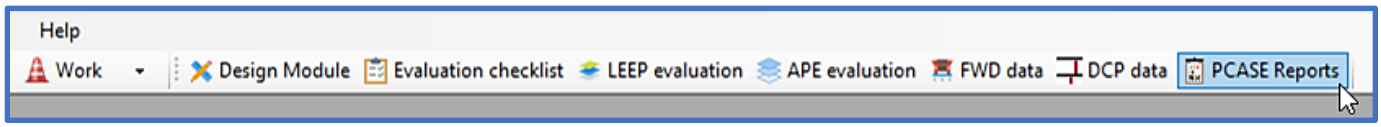
Step 8. Manually adjust the Weighted Average Statistic/Calculation type on the DCP Results Plot

- Navigate to the Layer Model grid and enter 83,000-psi for the Base layer modulus. This change will be reflected in the Statistic/Calculation Type visualization on the DCP Test Results plot.
- Similarly, navigate to the Layer Model grid and enter 25,000-psi for the Subgrade modulus

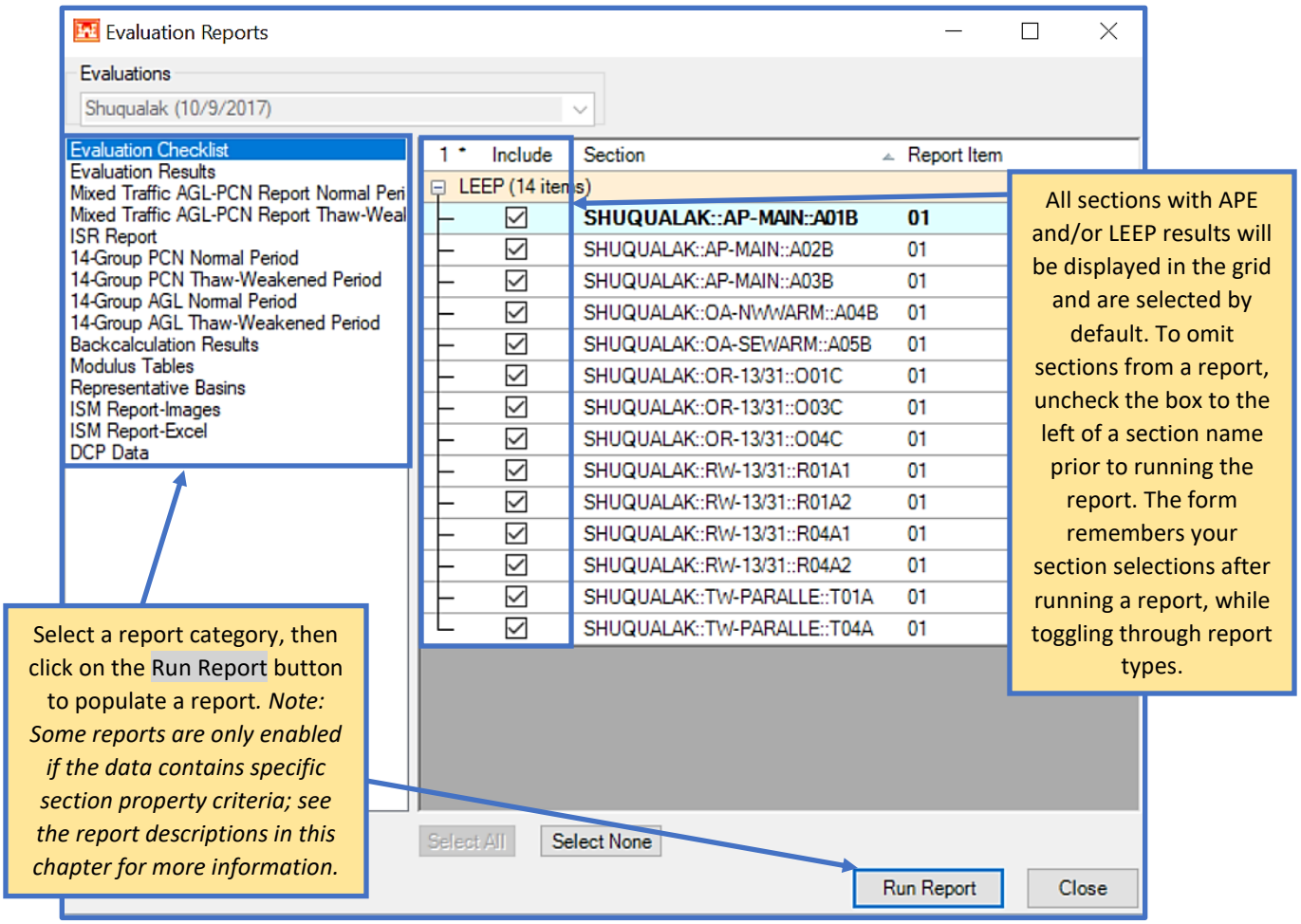


17 PCASE Reports

Evaluation Reports can be accessed from several different locations within the program including PCASE Reports, Evaluation Checklist, LEEP evaluation, and APE evaluation. *Note: The Reports button is only displayed in APE and LEEP after analysis results have populated in the Results section of the form.*



The Evaluation Reports window consists of an Evaluations field that lists all evaluations in the currently open database, report categories, and a grid which displays the sections that will be included in reports. After you select Run Report, a directory will open prompting you to save the report. After the report has been saved, an Excel sheet or report viewer will open displaying the report data.



17.1 Evaluation Checklist

The Evaluation Checklist report can be run as long as an evaluation with an inventory exists in a database. This report provides a summary of the pavement inventory and associated section property data for the selected evaluation.

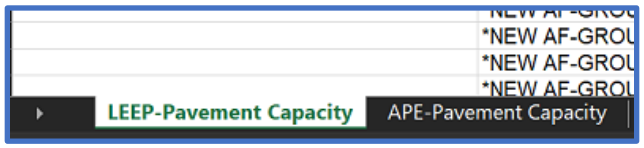
	A	B	C	D	E	F	G	H	I
1	Evaluation Checklist								
2	Inspection Date: 10/9/2017								
3	PCASE Development Build								
4	Section	Layer Model	Pavement Type	Evaluation Type	Active Structure	Traffic Assigned	Has Layers	Has NDT	Has Results
5	SHUQUALAK::AP-MAIN::A01B	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
6	SHUQUALAK::AP-MAIN::A02B	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
7	SHUQUALAK::AP-MAIN::A03B	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
8	SHUQUALAK::OA-NWWARM::A04B	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
9	SHUQUALAK::OA-SEWARM::A05B	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
10	SHUQUALAK::OR-13/31::O01C	01	Flexible	LEEP	Yes	Yes	Yes	No	Yes
11	SHUQUALAK::OR-13/31::O02C	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
12	SHUQUALAK::OR-13/31::O03C	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
13	SHUQUALAK::OR-13/31::O04C	01	Flexible	LEEP	Yes	Yes	Yes	No	Yes
14	SHUQUALAK::RW-13/31::R01A1	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
15	SHUQUALAK::RW-13/31::R01A2	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
16	SHUQUALAK::RW-13/31::R04A1	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
17	SHUQUALAK::RW-13/31::R04A2	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
18	SHUQUALAK::TW-PARALLE::T01A	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes
19	SHUQUALAK::TW-PARALLE::T04A	01	Rigid	LEEP	Yes	Yes	Yes	Yes	Yes

17.2 Evaluation Results

If LEEP and/or APE evaluation results exist in the currently open database; the Evaluation Results report will populate with layer model and analysis results data for each section.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	LEEP Results Report												
2	Inspection Date: 10/9/2017												
3	PCASE Development Build												
4	Section: SHUQUALAK::AP-MAIN::A01B	Layer Model: 01											
5													
6		Traffic Area:	Area B										
7		Condition:	0										
8		SCI for Evaluation:	0										
9		Joint Defl. Ratio:	0.76										
10		Cb:	0.75										
11		Cr:	0.75										
12													
13		Layer Information											
14		Layer Type	Material	Thickness (in)	Flex Strength	Modulus (psi)	Poisson's Ratio						
15		Portland Cement Concrete	Portland Cement	12.5	700	1014980	0.15						
16		Base	Unbound Aggregate	15		1000	0.35						
17		Subbase	Unbound Aggregate	22		10000000	0.35						
18		Compacted Subgrade	Cohesive Cut	197.5		10000000	0.4						
19		Bedrock	Bedrock	0		1000000	0.5						
20													
21													
22		Evaluation Results											
23		Vehicle	Load	Passes	ACN	PCN String	AGL (lb)	Allowable Passes					
24		*NEW AF-GROUP01	26750	2750	9.5	61/R/A/W/T	170868	1000000					
25		*NEW AF-GROUP01	26750	13750	9.5	50/R/A/W/T	139622	1000000					
26		*NEW AF-GROUP01	26750	45833	9.5	44/R/A/W/T	122780	1000000					
27		*NEW AF-GROUP01	26750	275000	9.5	37/R/A/W/T	103987	1000000					
28		*NEW AF-GROUP02	84200	2750	38.9	82/R/A/W/T	176345	1885983					
29		*NEW AF-GROUP02	84200	13750	38.9	65/R/A/W/T	140521	1885983					
30		*NEW AF-GROUP02	84200	45833	38.9	56/R/A/W/T	121020	1885983					
31		*NEW AF-GROUP02	84200	275000	38.9	46/R/A/W/T	99671	1885983					
32		*NEW AF-GROUP03	60500	2750	12.1	47/R/A/W/T	218970	1000000					
33		*NEW AF-GROUP03	60500	13750	12.1	39/R/A/W/T	181305	1000000					
34		*NEW AF-GROUP03	60500	45833	12.1	34/R/A/W/T	160425	1000000					
35		*NEW AF-GROUP03	60500	275000	12.1	29/R/A/W/T	136658	1000000					
36		*NEW AF-GROUP04	175000	458	36.2	101/R/A/W/T	483353	845722					
37		*NEW AF-GROUP04	175000	2750	36.2	75/R/A/W/T	357499	845722					

If the selected Evaluation contains both APE and LEEP evaluation results, the report will include two separate tabs for each respective module's results data.



17.3 Mixed Traffic AGL-PCN Report Normal Period

The Mixed Traffic AGL-PCN Report Normal Period option is only available for airfield sections that have APE and/or LEEP evaluation results, and must use a Mixed Traffic Analysis Type or an Air Force 14 Group traffic pattern. If an Air Force 14 Group traffic pattern is used for a section, the report will output a single row for the Group 10 vehicle at 585 kips and 50,000 passes.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Mixed Traffic AGL-PCN Report																
2	Inspection Date: 10/9/2017																
3	PCASE Development Build																
4																	
5	Pavement Facility			Section	Test Number or Station, ft		Design Aircraft					Allowable Gross Load, kips	PCN		Theoretical Overlay		
6																	
7							Aircraft	Weight, kips	Passes	ACN					AC	PCC No	PCC Part
8																	
9																	
10	Main Apron			A01B	-		*NEW AF-GROUP10	585	50,000	43/R/A/W/T		535	39/R/A/W/T		-	-	-

17.4 Mixed Traffic AGL-PCN Report Thaw-Weakened Period

The Mixed Traffic AGL-PCN Report Thaw-Weakened Period option is only available for airfield sections that have APE and/or LEEP evaluation results, and must use a Mixed Traffic Analysis Type or an Air Force 14 Group traffic pattern. If an Air Force 14 Group traffic pattern is used for a section, the report will output a single row for the Group 10 vehicle at 585 kips and passes are split between the normal period and thaw-weakened period, which results in 45,833 passes for the normal period and 4,167 passes for the thaw-weakened period.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Mixed Traffic AGL-PCN Report																
2	Inspection Date: 10/9/2017																
3	PCASE Development Build																
4																	
5	Pavement Facility			Section	Test Number or Station, ft		Design Aircraft					Allowable Gross Load, kips	PCN		Theoretical Overlay		
6																	
7							Aircraft	Weight, kips	Passes	ACN					AC	PCC No	PCC Part
8																	
9																	
10	Main Apron			A01B	-		*NEW AF-GROUP10	585	4,167	43/R/A/W/T		535	39/R/A/W/T		-	-	-

17.5 ISR Report

The ISR Report generates a spreadsheet that summarizes airfield pavement evaluation data. This report only applies to non-frost evaluations. The Combined Rating column is driven by the lower of either the PCI or the ACN/PCN column values, the rules are as follows:

Red ISR Rating	**0 < PCI ≤ 55**
Amber ISR Rating	**55 < PCI ≤ 70**
Green ISR Rating	**70 < PCI ≤ 100**

or

Red ISR Rating	**ACN/PCN > 1.4**
Amber ISR Rating	**1.1 < ACN/PCN ≤ 1.4**
Green ISR Rating	**ACN/PCN ≤ 1.1**

The Work Classification columns are based on the following rules:

Reconstruction	**PCI ≤ 25**
Major repair	**PCI > 25 and ≤ 40**
Localized repair with medium and high-severity distress	**PCI > 40**
Do nothing with low-severity distress	**PCI > 40**

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	ISR Report												
2	Inspection Date: 6/29/2015												
3	PCASE Development Build												
4	Branch	Section	ISR			Work Classification							
5			PCI	ACN/ PCN	Combined Rating	Do Nothing		Localized M&R		Major M&R		Reconstruction	
7	RW0826	R01A	100	0.5	Green	X							
8		R03A	100	0.8	Green	X							
9		R04A	100	0.7	Green	X							
10		R05A	50	0.7	Red	X							
11		R06A	40	1.1	Red					X			
12		R07A	100	0.8	Green	X							
13	TWA	T01A	30	1.1	Red					X			

17.6 14-Group PCN Normal Period

Only sections with LEEP and/or APE analysis results using an Air Force 14 Group traffic pattern will display when the 14-Group PCN Normal Period report has been selected. This report contains a summary of non-frost PCN results for each section in the selected evaluation; based on Group 10 pass intensity level 1 (50,000 passes of the C-17).

	A	B	C	D	E	F	G	H
1	PAVEMENT CLASSIFICATION NUMBER							
2	Normal Period							
3	PCASE Development Build							
4	SECTION	PCN	SECTION	PCN	SECTION	PCN	SECTION	PCN
5	A01B	39/R/A/W/T						
6	A02B	36/F/A/W/T						
7	A03B	39/F/A/W/T						
8	A04B	55/F/A/W/T						
9	A05B	54/F/A/W/T						

17.7 14-Group PCN Thaw-Weakened Period

Sections with LEEP and/or APE analysis results using an Air Force 14 Groups traffic pattern are available for selection for the 14-Group PCN Thaw-Weakened Period report. If frost was a consideration for the sections included in the report; then the frost PCN for each section will be displayed (based on 50,000 passes of a C-17).

	A	B	C	D	E	F	G	H
1	PAVEMENT CLASSIFICATION NUMBER							
2	Thaw Weakened Period							
3	PCASE Development Build							
4	SECTION	PCN	SECTION	PCN	SECTION	PCN	SECTION	PCN
5	A01B	39/R/A/W/T						
6	A02B	36/F/A/W/T						
7	A03B	53/R/A/W/T						
8	A04B	98/R/A/W/T						
9	A05B	47/R/B/W/T						
10	O01C	69/F/B/W/T						

17.8 14-Group AGL Normal Period

Sections with LEEP and/or APE analysis results using an Air Force 14 Group traffic pattern are displayed when the 14-Group AGL Normal Period report has been selected. This report displays the non-frost Allowable Gross Loads for the Air Force 14 Groups and 4 pass intensity levels.

Red	**AGL < lightest aircraft in group**
Yellow	**AGL ≥ lightest and < heaviest aircraft**
Green	**AGL ≤ heaviest aircraft**

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	SUMMARY OF ALLOWABLE GROSS LOADS															
2	Normal Period															
3	PCASE Development Build															
4			PAVEMENT CAPACITY IN KIPS FOR AIRCRAFT GROUP INDEX NUMBERS													
5 6 7	SECTION NAME	PASS INTENSITY LEVEL	1	2	3	4	5	6	7	8	9	10	11	12	13	14
8	A01B	I	104	100	137	241	132	158	151	365	414	535	966	553	800	275
9		II	123	121	160	282	150	180	173	421	479	611	1100	644	922	332
10		III	140	141	181	357	184	219	213	527	606	753	1338	821	1154	430
11		IV	171	176	219	483	243	287	279	711	836	991	1719	1157	1588	581
12	A02B	I	93	89	117	188	116	133	128	268	299	406	670	399	583	218
13		II	110	107	137	220	132	152	146	306	342	459	756	458	664	259
14		III	126	124	155	279	162	186	180	378	423	557	909	569	815	331
15		IV	154	156	188	382	214	244	236	506	571	724	1167	771	1086	439
16	A03B	I	125	123	181	348	166	213	204	539	561	719	1366	721	1055	371
17		II	148	150	212	404	190	241	235	629	663	833	1558	859	1239	456
18		III	168	174	239	501	232	293	288	787	855	1032	1881	1132	1606	607
19		IV	205	217	288	665	305	382	381	1045	1170	1342	2381	1594	2273	836
20	A04B	I	172	181	272	577	242	328	328	949	1020	1297	2415	1373	1955	653
21		II	203	217	318	656	275	370	375	1083	1184	1470	2702	1622	2335	820
22		III	230	249	358	798	334	447	459	1316	1461	1761	3191	2030	2964	1082
23		IV	281	307	432	1045	436	580	599	1704	1900	2214	3965	2670	3898	1420
24	A05B	I	109	104	151	280	141	175	166	443	479	589	1153	618	908	311
25		II	128	127	177	329	161	200	192	516	562	679	1320	730	1059	379
26		III	146	146	200	414	197	243	237	650	725	843	1607	955	1338	497
27		IV	179	186	241	555	260	318	312	874	1007	1113	2054	1364	1916	683
28	O01C	I	155	160	198	350	194	225	224	468	558	835	1540	752	1122	537
29		II	175	183	223	383	212	245	245	510	612	916	1684	826	1229	607
30		III	191	199	242	432	237	275	276	573	691	1035	1896	937	1390	772
31		IV	214	224	271	545	297	345	348	717	879	1310	2383	1202	1773	976
32	O03C	I	12	10	20	27	21	24	24	58	65	90	167	81	122	55
33		II	15	12	24	31	24	27	27	66	73	100	186	91	136	64
34		III	18	14	28	41	28	33	32	79	87	118	218	109	163	80
35		IV	24	18	36	59	37	43	41	102	112	146	270	140	208	103
36	O04C	I	35	33	65	78	55	69	68	151	150	244	484	186	298	151
37		II	41	38	76	86	60	75	74	166	164	265	537	202	325	169
38		III	45	41	85	99	67	86	84	189	184	301	620	226	366	211
39		IV	51	47	97	133	85	111	109	245	238	397	833	291	472	270
40		I	27	29	45	81	43	53	58	142	157	200	371	211	329	119

17.9 14-Group AGL Thaw-Weakened Period

Sections with LEEP and/or APE analysis results using an Air Force 14 Group traffic pattern are displayed when the 14-Group AGL Thaw-Weakened Period report has been selected. Color-coded frost Allowable Gross Loads for the Air Force 14 Group and 4 pass intensity levels are displayed in this report.

SUMMARY OF ALLOWABLE GROSS LOADS
Thaw-Weakened Period
PCASE Development Build

SECTION NAME	PASS INTENSITY LEVEL	PAVEMENT CAPACITY IN KIPS FOR AIRCRAFT GROUP INDEX NUMBERS													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
A02B	I	93	89	117	188	116	133	128	268	299	406	670	399	583	218
	II	110	107	137	220	132	152	146	306	342	459	756	458	664	259
	III	126	124	155	279	162	186	180	378	423	557	909	569	815	331
	IV	154	156	188	382	214	244	236	506	571	724	1167	771	1086	439
A03B	I	125	123	181	348	166	213	204	539	561	719	1366	721	1055	371
	II	148	150	212	404	190	241	235	629	663	833	1558	859	1239	456
	III	168	174	239	501	232	293	288	767	855	1032	1881	1132	1606	607
	IV	205	217	288	665	305	382	381	1045	1170	1342	2381	1594	2273	836
A04B	I	172	181	272	577	242	328	328	949	1020	1297	2415	1373	1955	653
	II	203	217	318	656	275	370	375	1083	1184	1470	2702	1622	2335	820
	III	230	249	358	798	334	447	459	1316	1461	1761	3191	2030	2964	1082
	IV	281	307	432	1045	436	580	599	1704	1909	2214	3965	2670	3930	1432
A05B	I	109	104	151	280	141	175	166	443	479	589	1153	618	908	311
	II	128	127	177	329	161	200	192	516	562	679	1320	730	1059	379
	III	146	148	200	414	197	243	237	650	725	843	1607	953	1353	497
	IV	179	186	241	555	260	318	312	874	1007	1113	2054	1364	1916	683
O01C	I	155	160	196	350	194	225	224	468	558	835	1540	752	1122	537
	II	175	183	223	383	212	245	245	510	612	916	1684	826	1229	607
	III	191	199	242	432	237	275	276	573	691	1035	1896	937	1390	772
	IV	214	224	271	545	297	345	348	717	879	1310	2388	1202	1773	978
O03C	I	12	10	20	27	21	24	24	58	65	90	167	81	122	55
	II	15	12	24	31	24	27	27	66	73	100	186	91	136	64
	III	18	14	28	41	28	33	32	79	87	118	218	109	163	80
	IV	24	18	36	59	37	43	41	102	112	146	270	140	208	103
O04C	I	35	33	65	78	55	69	68	151	150	244	484	186	298	151
	II	41	38	78	86	60	75	74	166	164	265	537	202	325	169
	III	45	41	85	99	67	86	84	189	184	301	620	228	366	211
	IV	51	47	97	133	85	111	109	245	238	397	833	291	472	270
R01A1	I	27	29	45	81	43	53	58	142	167	200	371	211	328	119
	II	32	34	52	91	48	59	65	159	175	222	411	238	388	140
	III	36	39	58	109	57	70	77	189	208	260	481	280	437	173
	IV	43	47	69	139	73	89	97	239	264	321	594	353	551	221
	I	24	26	38	68	36	45	48	124	139	168	321	187	290	100

17.10 Backcalculation Results

The Backcalculation Results report displays sections within an evaluation that are associated with backcalculation results. Detailed Basin Results and the section's coinciding Layers grid details are summarized in this report.

Backcalculation Results Report
Inspection Date: 10/9/2017
PCASE Development Build

Section: SHUQUALAK::AP-MAIN::A01B Layer Model: 01

Layer Information

Layer Type	Material	Thickness (in)	Seed (psi)	Min (psi)	Max (psi)	Poisson's Ratio	Bond
Portland Cement Concrete	Portland Cement	12.5	5000000	2500000	10000000	0.15	Partially Bonded
Base	Unbound Aggregate	15	32000	5000	150000	0.35	Fully Bonded
Subbase	Unbound Aggregate	22	31000	5000	150000	0.35	Fully Bonded
Compacted Subgrade	Cohesive Cut	197.5	14650	9650	19650	0.4	Fully Bonded
Bedrock	Bedrock	0	1000000	1000000	1000000	0.5	Fully Bonded

Station Information

Station	Drop	Load (lb)	E1 (psi)	E2 (psi)	E3 (psi)	E4 (psi)	Deflection	Basin RMSE	D1 (mil)	D2 (mil)	D3 (mil)	D4 (mil)	D5 (mil)
90	2	52888	1329501	1000	10000000	10000000	Measured		49.22	41.64	32.35	24.19	17.43
							Computed	27.1%	47.16	41.36	35.09	28.57	22.43
90	3	52877	1210047	1000	10000000	10000000	Measured		51.82	43.51	33.38	24.7	17.72
							Computed	27.1%	49.6	43.26	36.48	29.48	22.94
91	2	52603	1129628	1000	10000000	10000000	Measured		53.5	44.63	33.99	25.02	17.91
							Computed	27.0%	51.21	44.48	37.34	30	23.18
91	3	52658	1077986	1000	10000000	10000000	Measured		54.93	45.58	34.56	25.33	18.07
							Computed	26.8%	52.57	45.54	38.1	30.49	23.45
92	2	52242	1014980	1000	10000000	10000000	Measured		56.19	46.52	35.1	25.67	18.26
							Computed	25.7%	53.88	46.5	38.74	30.84	23.57
92	3	52187	981222	1000	10000000	10000000	Measured		57.18	47.14	35.5	25.9	18.38
							Computed	25.5%	54.82	47.21	39.23	31.14	23.72
93	2	52296	534113	2205	10000000	9134	Measured		60.27	47.85	35.89	28.1	18.52
							Computed	1.0%	60.55	47.73	36.38	26.38	18.47
93	3	52231	561282	2010	10000000	11053	Measured		59.06	48.29	36.2	26.28	18.59
							Computed	2.6%	60.45	48.15	37.04	27.07	19.04
94	2	52165	898609	1000	10000000	10000000	Measured		59.95	48.89	36.56	26.5	18.73
							Computed	24.7%	57.47	49.21	40.64	32	24.14
94	3	52044	525177	2086	10000000	9724	Measured		60.49	49.13	36.73	26.62	18.77
							Computed	1.6%	61.88	48.86	37.29	27.04	18.89

Representative basin is Station 92, Drop 2

BackcalculationResults

17.11 Modulus Tables

The Modulus Tables report can be run for LEEP evaluation sections that have backcalculation data and analysis results. Modulus values for each section and layer are displayed in this report.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Layered Elastic Model Data														
2	Inspection Date: 10/9/2017														
3	PCASE Development Build														
4	Section	Layer 1				Layer 2				Layer 3			Layer 4		
5		Thickness (in)	Type	Modulus (psi)	Flex. Str. (psi)	Thickness (in)	Type	Modulus (psi)	Flex. Str. (psi)	Thickness (in)	Type	Modulus (psi)	Thickness (in)	Type	Modulus (psi)
6	A01B	12.50	PCC	1,014,980	700	15.00	BASE	1,000		22.00	SBASE	10,000,000	197.50	CSUBG	10,000,000
7	A02B	12.50	PCC	5,000,000	700	15.00	BASE	32,000		22.00	SBASE	5,000	190.50	CSUBG	21,959
8	A03B	12.00	PCC	1,519,542	700	20.00	BASE	61,000		30.00	SBASE	24,000	196.00	CSUBG	11,681
9	A04B	12.50	PCC	388,565	700	33.00	BASE	32,000		45.00	SBASE	5,000	200.50	CSUBG	9,174
10	A05B	12.00	PCC	768,810	700	28.00	BASE	5,258					206.00	CSUBG	14,126
11	O02C	12.00	PCC	438,473	700	15.00	BASE	2,040		30.00	SBASE	45,000	228.00	CSUBG	28,124

This report also has a Backcalculation Settings tab which displays the Backcalculation Method that was used for each section in the report and whether or not a bedrock layer was present.

	A	B	C
1	Backcalculation Parameter Settings		
2	Inspection Date: 10/9/2017		
3	PCASE Development Build		
4	Section	Backcalculation Method	Bedrock Layer?
5	A01B	YULEA	Yes
6	A02B	YULEA	Yes
7	A03B	YULEA	Yes
8	A04B	YULEA	Yes
9	A05B	YULEA	Yes
10	O02C	YULEA	Yes
11	O03C	YULEA	Yes
12	R01A1	WESDEF	No
13	R01A2	WESDEF	No
14	R04A1	WESDEF	No
15	R04A2	WESDEF	No
16	T01A	YULEA	Yes
17	T04A	YULEA	Yes

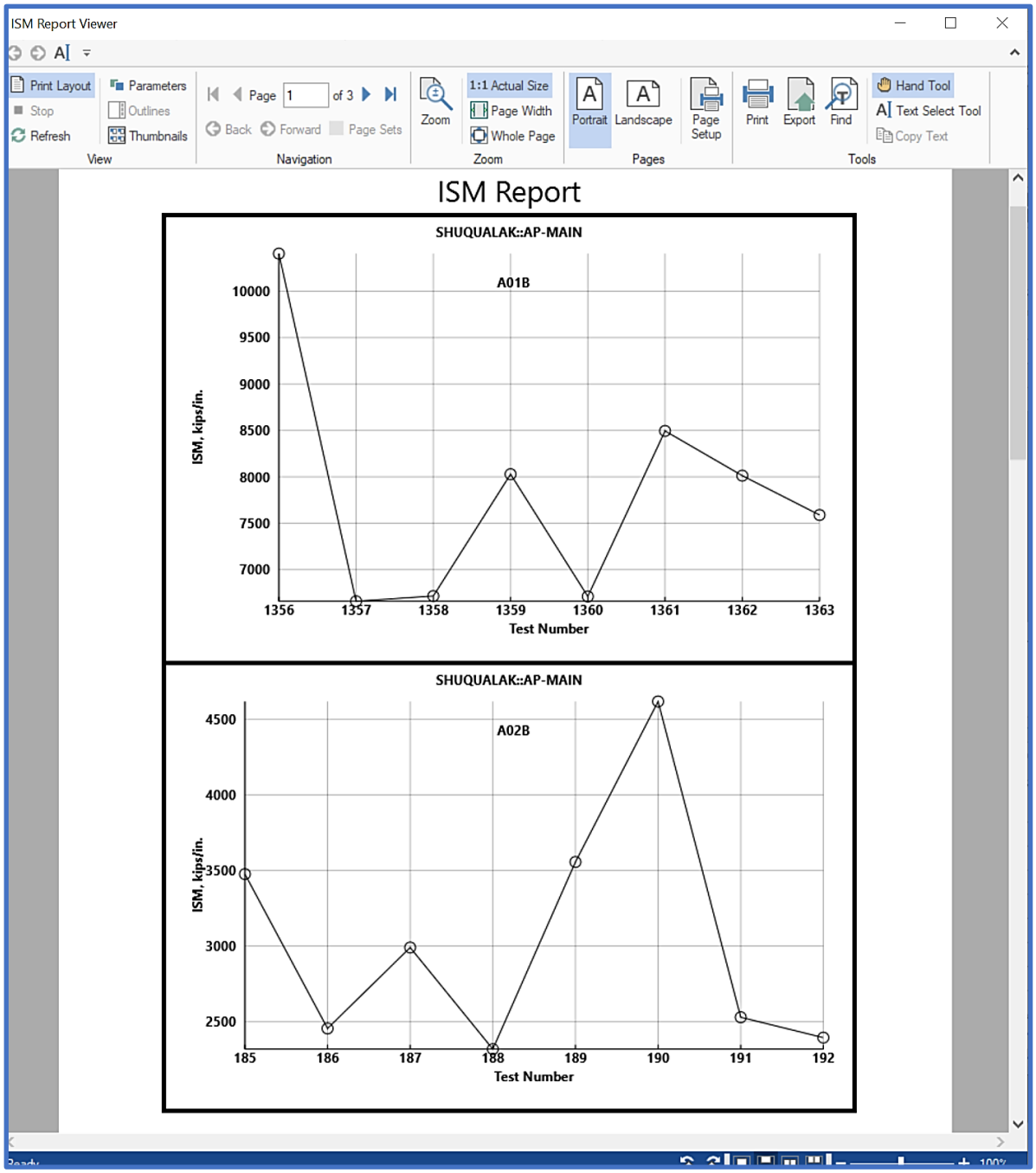
17.12 Representative Basins

The Representative Basins report option becomes available when sections or layer models in the selected LEEP evaluation have a representative basin. A summary of representative basin data is provided for each applicable section. The report format changes based on the selected Service in the Evaluation Manager.

	A	B	C	D	E	F	G	H	I	J
1	Representative Basins									
2	Inspection Date: 10/9/2017									
3	PCASE Development Build									
4	Section	ISM, kips/in.	Load, lbs.	Deflection, mils						
5				D1	D2	D3	D4	D5	D6	D7
6	Main Apron									
7	A01B	930	52,242	56.19	46.52	35.10	25.67	18.26	12.37	8.65
8	A02B	2,477	55,857	22.55	20.64	18.01	15.10	12.50	9.85	7.47
9	A03B	1,839	55,298	30.07	26.74	22.47	18.17	14.65	11.79	9.42
10	Northwest Warmup Apron									
11	A04B	702	50,357	71.72	60.92	48.42	37.55	28.59	20.73	14.18
12	Southeast Warmup Apron									
13	A05B	855	52,231	61.07	52.89	41.71	31.88	24.14	18.36	13.96
14	Overrun Runway 13/31									
15	O02C	682	28,766	42.19	34.46	24.82	16.97	11.55	8.05	5.99
16	O03C	581	28,131	48.43	41.28	31.98	23.56	16.85	11.52	7.98
17	Runway 13/31									
18	R01A2	821	51,672	62.90	56.81	42.66	32.26	23.39	16.52	11.36
19	R04A1	847	52,307	61.78	51.16	39.22	29.16	21.47	15.60	12.04
20	R04A2	916	52,526	57.34	47.49	36.41	27.13	20.03	14.26	10.98
21	Parallel Taxiway									
22	T01A	812	52,099	64.17	54.16	43.24	33.96	26.27	19.58	13.50
23	T04A	681	50,752	74.55	63.89	51.63	40.95	31.50	22.82	15.35

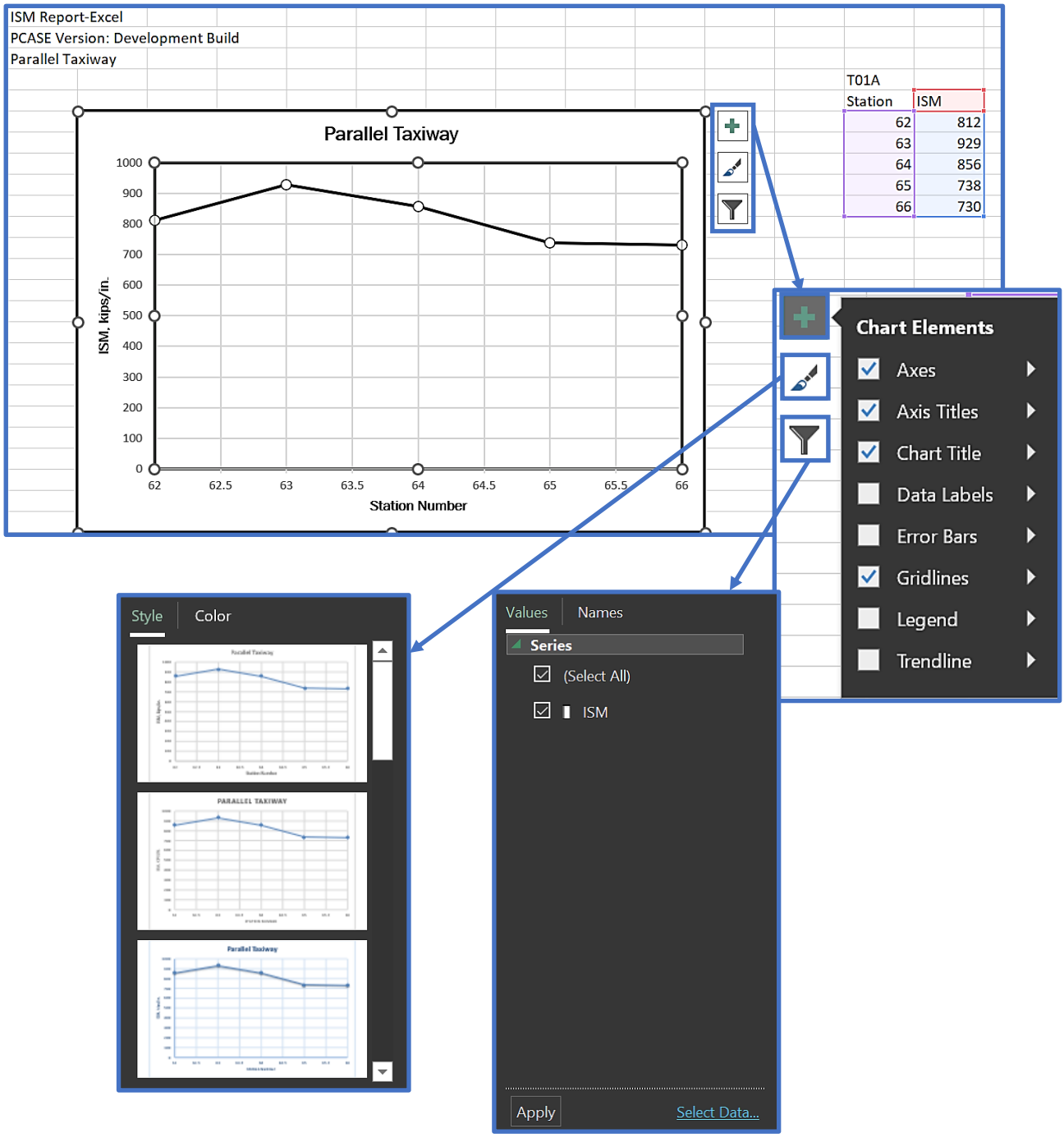
17.13 ISM Report - Images

The image ISM report can be executed for LEEP evaluation sections that have associated FWD data and selected basins. When ISM Report-Images is selected, a report viewer is launched that displays images of the ISM plots for each section. The report viewer includes additional functionalities for viewing, saving, exporting, and printing the report.



17.14 ISM Report - Excel

The Excel version of the ISM report produces a spreadsheet with interactive graphs/data. Each spreadsheet tab is separated by Branch name for the selected evaluation and ISM data is organized by Section, within each Branch tab. Select a graph to populate options for viewing chart elements, modifying the style and/or color of graphs, and value/name filters. The Station and ISM data to the right of each graph is bound to each coinciding plot; the graph will respond to changes made to this data.



17.15 DCP Data

The DCP Data report displays a summary of imported DCP test data within an evaluation. In order to launch the DCP Data report viewer, there must be DCP test data associated with the selected evaluation. When the DCP Data report is selected, any tests within the selected evaluation will be automatically selected by default. Tests can be unselected within the grid prior to running the report. The report viewer includes options to view, save, export, or print the report.